RAILROAD GAZETTE

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Contributions

The Cost of Bad Water.

Minneapolis, Minn., June 5, 1900.

TO THE EDITOR OF THE RAILROAD GAZETTE:

I have read with great interest the papers recently published in the *Railroad Gazette* on the "Work of Railroad Men on the Problem of Pure Water for Steam Boilers." It is gratifying to notice the high appreciation of the work of the old committee. Of course, the subject ought to interest all railroad managers, and if they will read these papers they will be likely to see something of the enormous advantages to be derived from the use of pure water for locomotives, and they will wonder why it has taken 30 years to find a simple and economical remedy.

But there are some who doubt the destructive effects of bad water, as shown and proved by the exhaustive investigation of that old committee, and hence the process of evolution will still be slow, for those in the highest authority in railroad management have yet to be educated.

COMMITTEEMAN.

The Slide Rule for Earthwork Computation.

Philadelphia, Pa., June 10, 1900.

TO THE EDITOR OF THE RAILROAD GAZETTE:

The review of my book on "Railroad Construction," published in a recent number of the *Railroad Gazette*, was, on the whole, fair, but I was sorry to note that the hasty reading of the reviewer had caused him to fail to appreciate the true limitations of the use of the slide-rule for earthwork computations, and that his comment was somewhat unjust.

He said of the slide rule that "it, however, involves a possible error of less than 10 yards for sections containing between 1,000 and 5,000 yards." The word "section" as used above is misleading and even wrong. The method of computation developed in the book is that of summing the volumes of elementary triangular prismoids into which the "section" is divided. It should be noted that in all earthwork computations the numerical volume computed is that of some geometrical solid which is *assumed* to represent the actual form of the earthwork, and that a considerable element of inaccuracy lies in the estimation of the *surface* faces of the prismoids. A single triangular prismoid having a volume of, say, 3,000 cubic yards would require bases of 810 sq. ft., or, say, triangles of 81 ft. wide and 20 ft. high. The assumption that any such mass of earthwork may be correctly represented by a single triangular prismoid should never be made except in approximate computations.

When earthwork is carefully computed as a basis for payments it is nearly always necessary to divide the sections longitudinally into comparatively small elementary triangular prismoids, and for such computations the slide-rule method is very accurate and rapid. For rough estimates, when the cross-sections are roughly taken and the elementary volumes are large, the slide rule gives the approximate volume with all necessary accuracy, but I claim that, far from "estimating and checking" being "its only use," the slide rule can rightfully be used for the most accurate computations, since when the elementary volumes are small the accuracy is unquestioned, and when they are large there is a considerable probability of error, independent of the slide rule. The slide rule has already been tested in practical use and its essential accuracy has been demonstrated. It has been found that when the elementary volumes are made as small as accuracy really requires, "two persons calculating from the same notes" will get identically "the same result."

The engravings on tunnel timbering, which the reviewer assumed to be taken from Drinker's "Tunneling," were really taken from Rziha's "Tunnelbaukunst."

WALTER LORING WEBB.

Railroad Bearing Metals.

The Ajax Metal Company,
Philadelphia, June 7, 1900.

TO THE EDITOR OF THE RAILROAD GAZETTE:

I note with interest the article in the June 1 issue of your valuable paper on Railroad Bearings, by Mr. Job. This subject being one in which the writer is personally interested, and one in which he has done considerable work, he finds himself called upon to make a few remarks on the subject.

It is gratifying to know that railroad men have grasped so quickly the importance of studying the structural arrangement of the metals which go to make up their bearings, as well as the mere making of chemical analysis, to see that the components are in proper proportion. Metallography, the new science, goes hand in hand with chemical analysis and physical testing, in solving the mysteries presented by the failure in service of all kinds of metallic constructions, and the study of the cause of failure in bearings presents a special interest for microscopic investigation.

There is one statement in Mr. Job's paper, however, which I can not pass without comment. In speaking of the valuable experiments made by Dr. Dudley (Franklin Institute Journal, 1892), and the advantages he showed to be due to the increase of lead in the copper, tin and lead alloy, he says, the proportion of lead is limited to 15 per cent. in the best practice, in order to maintain sufficient strength and fairly high melting point. I have before me a copy of Dr. Dudley's statements regarding these experiments, and see no mention of strength or melting point, in fact, he clearly states that his experiments were stopped because of his inability to get homogeneous castings when proportions of the Ex. B metal were much exceeded.

I think it only fair at this point to remark that the Ajax Metal Co., the originators of the copper, tin and lead alloy, without phosphorus, have recently been granted patents on the process for alloying any percentage of lead in this alloy for the production of homogeneous castings. They are recommending for car service an alloy of 30 per cent. lead, 5 per cent. tin, together with copper. This alloy has compressive strength of 17,000 lbs. per sq. in. to the yield point, and has been found to be abundantly strong in the severest service of one of the largest railroads in the country.

Furthermore, the melting point of the copper, tin and lead alloy is very little, if at all, affected by the presence of lead. It has been fully demonstrated that lead is only mechanically held in this alloy, and it matters little, so far as melting point is concerned, whether the alloy contains 10 per cent., 20 per cent. or 30 per cent. of lead. I will grant, however, that when lead is the basis of the alloy, as in soft metal lining, the low melting point is objectionable, but where it is held in the walls of a high melting point alloy, like copper and tin, I see no foundation for such an assertion. The merits of the 30 per cent. lead alloy as compared with 15 per cent. are beyond question. The wear, friction, cost, temperature of running, consumption of oil and liability of heating are all diminished. These are proved facts.

THE AJAX METAL COMPANY.

Master Car Builders' Convention.

The first session of the Thirty-fourth Annual Convention of the Master Car Builders' Association will be called to order at 10 a. m., on Monday, June 18, at Saratoga, N. Y. Reading and discussing questions propounded by members is the special order at 12 o'clock noon of each day. The subjects for topical discussion, as prepared by the committee, are as follows:

1. When pressed steel trucks are broken on a foreign road, should not repairs be made by the manufacturer or the owners, in place of repairs being attempted by the road on which the car may be? To be opened by Mr. B. Haskell.

2. How soon after a new car is built should it be reweighed to modify the original stencil weight; at what intervals should it be reweighed thereafter, and what should be the minimum variation from the previous stencil weight for which change should be made? To be opened by Mr. F. A. Delano.

3. To what extent is it desirable to equip cars with permanent check chains now shown under the Recommended Practice of the Association? To be opened by Mr. R. P. C. Sanderson.

4. Should not a standard wrecking chain be adopted which can be interchanged between roads with cars, without necessitating removal? To be opened by Mr. S. F. Prince, Jr.

5. Good methods for terminal cleaning of passenger cars, and is it advisable to have oil in cleaning mixture? To be opened by Mr. A. M. Waitt.

6. Is a charge against the car owner, for repairs on account of truing up tapered journals, correct and proper? To be opened by Mr. G. W. Rhodes.

Under the head of "Reports of Committees" will come the reports of the following standing committees:

Arbitration.—G. W. Rhodes, Chairman; John Mackenzie, M. M. Martin, G. L. Potter and J. N. Barr.

Supervision of Standards and Recommended Practice.—A. M. Waitt, Chairman; G. L. Potter and Wm. Apps.

Triple Valve Tests.—G. W. Rhodes, Chairman; A. W. Gibbs, J. O. Pattee, W. S. Morris and Wm. McIntosh.

Brake Shoe Tests.—S. P. Bush, Chairman; George Gibbs and R. P. C. Sanderson.

Prices in M. C. B. Rules.—J. N. Barr, Chairman; S. P. Bush, J. H. McConnell, S. A. Charpiot and T. B. Purves, Jr.

Tests of M. C. B. Couplers.—W. W. Atterbury, Chairman; W. P. Appleyard, F. A. Delano, W. S. Morris and H. Monkhouse.

The committees appointed to report at this convention are as follows:

1. Air Brake Appliances.—A. L. Humphrey, Chairman; A. M. Waitt and W. H. Marshall.

2. Design for Wheel Circumference Measure.—J. J. Hennessey, Chairman; and E. S. Marshall.

3. Design for Journal Box, Bearing, Wedge and Lid for 100,000-lb. Capacity Cars; also Design for Journal Bearing and Wedge Gages for 80,000 and 100,000-lb. Cars.—Wm. Garstang, Chairman; J. J. Hennessey and W. H. Marshall.

4. Revision of Rules for Loading Long Materials.—Pulaski Leeds, Chairman; P. H. Peck, F. H. Stark, C. Coller, S. P. Bush, B. Haskell, W. H. Lewis and J. R. Petrie.

5. Revision of Recommended Practice for Springs, Including Design for Springs for 100,000-lb. Cars.—R. P. C. Sanderson, Chairman; A. G. Steinbrenner and F. W. Brazier.

6. Revision of Passenger Car Rules.—H. T. Small, Chairman; J. T. Chamberlain, Frank Rearden, H. F. Bail and Wm. Garstang.

7. Standard Center Plates.—R. H. Johnson, Chairman; H. L. Preston and G. T. Anderson.

8. Draft Gear.—J. R. Slack, Chairman; James Macbeth and W. E. Sharp.

9. Spread and Design for Side Bearings.—J. W. Luttrell, Chairman; H. M. Pflager and B. Haskell.

10. Uniform Section of Siding and Flooring.—R. P. C. Sanderson, Chairman; W. P. Appleyard and J. S. Lentz.

11. Metal Dead Blocks; Safety Chains.—W. P. Appleyard, Chairman; J. H. Pennington and Wm. McIntosh.

12. Subjects.—G. L. Potter, Chairman, A. M. Waitt and A. E. Mitchell.

Master Mechanics' Convention.

The American Railway Master Mechanics' Association will meet in its thirty-third annual convention at 9 a. m. on Thursday, June 21, at Saratoga, N. Y. Reading of papers and discussion of questions propounded by members is the special order from 12 o'clock noon until 1 p. m. of each day. The committee on subjects proposes the following for topical discussion:

1. The best method for securing eccentric straps to the rods. To be opened by C. H. Quereau.

2. Nickel-steel as a journal bearing. Is there any noticeable increase in friction or wear, as compared with the ordinary steel or iron? To be opened by W. H. Lewis.

3. Has the limit of length of tubes, 2 in. in diameter, been reached in locomotive practice? To be opened by S. M. Vauclain.

4. Metal versus wooden cabs for locomotives. To be opened by J. E. Sague.

5. Strap versus jaw, back end of main rod. To be opened by S. P. Bush.

6. Graphite as a locomotive lubricant. To be opened by G. R. Henderson.

7. Advantages of increasing ratio of grate area to heating surface in locomotives burning bituminous coal. To be opened by F. A. Delano.

8. How to make pooling of locomotives a success. To be opened by G. W. Rhodes.

Under the head of "Reports of Committees" will come the reports of the following committees:

1. The Extent to Which the Recommendations of This Association Have Been Put into Practice.—F. A. Delano, Chairman; M. Middleton and A. Sinclair.

2. Relative Merits of Cast-Iron and Steel-Tired Wheels.—J. N. Barr, Chairman; A. M. Waitt, A. L. Humphrey, H. S. Hayward and John Hickey.

3. Advantages of Ton-mile Basis for Motive Power Statistics.—H. J. Small, Chairman; C. H. Quereau and W. H. Marshall.

4. Flanged Tires.—S. Higgins, Chairman; W. H. Thomas and Wm. Garstang.

5. Compound Locomotives.—J. F. Deems, Chairman; A. E. Mitchell, J. E. Sague, John Player and J. H. Setchel.

6. Piston Valves.—S. P. Bush, Chairman; H. Schlacks and Wm. McIntosh.

7. Journal Bearings, Cylinder Metals and Lubrication.—W. C. Dallas, Chairman; J. B. Barnes and George F. Wilson.

8. Power Transmission by Shafting vs. Electricity.—George Gibbs, Chairman; F. Mertsheimer, W. A. Nettleton, Wm. Renshaw and R. A. Smart.

9. Best Type of Stationary Boiler for Shop Purposes.—J. F. Dunn, Chairman; John Hickey and J. J. Ryan.

10. What Can the American Railway Master Mechanics' Association Do to Increase Its Usefulness?—T. R. Browne, Chairman; G. M. Basford and L. R. Pomeroy.

11. Subjects.—Robert Quayle, Chairman; G. W. Rhodes and F. D. Casanave.

Tests of Westinghouse and New York Triple Valves.

In several instances lately, mechanical departments of railroads have been called on for an opinion as to the practicability of operating trains of freight cars having some Westinghouse and some New York air brakes, and such requests invariably bring out the fact that no definite information has been published on this subject. As is well known, the Master Car Builders' Association has, so far, not succeeded in arranging for tests of New York triple valves, and in the absence of reliable data a number of roads have been obliged to make such trials as their imperfect facilities would allow, and as a rule these tests have been crude. To add to the little that is known about the use of Westinghouse and New York brakes in the same train, the *Railroad Gazette* was recently permitted to use the excellent brake rack of the American Brake Company at St. Louis, Mo., and was given such other assistance as to make it possible to carry out a series of experiments with the two kinds of brakes. The results of these tests are given in full in this issue, and the summing up of these results is that the Westinghouse triple valves conform to the requirements of the M. C. B. Association, while in several important respects the New York triples do not so conform. Further, on account of radical differences in the construction of the two kinds of triples, the introduction of the New York triples in the same train is liable to seriously impair the proper working of all the brakes of the train.

Brake Rack.—The brake rack at St. Louis, used in the tests, corresponds to a train of 50 freight cars, each car having 51 ft. 1½ in. of pipe, all 1¼ in. in diameter excepting a piece about 8 in. long between each triple valve and the first L; these short pieces are of 1-in. pipe. It may be noted that this is a little more piping than is commonly required for 34-ft. cars. A full complement of angle cocks and hose and hose couplings are used, spaced as on cars. The engraving, Fig. 1, shows the general arrangement of the piping and brake cylinders, which are placed in four rows, there being 12 cylinders in each of the upper rows and 13 in each of the lower rows. The brake cylinder of the first car is directly above that of the last car and these, together with car No. 25, are fitted with duplex gages showing both the brake cylinder and auxiliary reservoir pressures. These gages and the gage showing train pipe and main reservoir pressure are mounted above the engineer's brake valves, which in turn are at the end of the rack near the first and last cylinders; the brake valves are not shown in the engraving. The Westinghouse brake valve (engineer's valve) used was of the Plate F-6 type, known as the 1892 model, and the New York brake valve was of the Vaughan-McKee type. These are so connected up that either can be cut in simply by opening and closing cocks, the piping being exactly alike for both. The brake valves are on a loop of 1-in. pipe, 65 ft. long, corresponding to the piping of a locomotive and tender with the brakes cut out, and by changing the hose couplings above, either brake valve can be worked at the head or at the rear of the rack. There are two main reservoirs which have together a total volume of about 115,000 cu. in. and air is supplied by a Westinghouse, 9½-in. pump. The large main reservoir can be cut out leaving a small reservoir of about 20,000 cu. in. All the cylinders, reservoirs and fittings used in the tests were standard Westinghouse freight brake equipment.

Table 1.—Brake Cylinder Pressure, lbs.

Piston travel.	First car. Westinghouse.	Second car. Westinghouse.	Second car. New York.	Third car. Westinghouse.	Third car. New York.
4-inch.....	56	56	57	56	57
	56	55	56	56	56
	56	56	56	56	56
6-inch.....	52	51	51	51	53*
	51	52	52	52	54*
	51	51	51	51	53*
12-inch.....	44	40	41	44	44*
	43	40	41	42.5	45
	42.5	40	40	43	44*

*The initial auxiliary reservoir pressure in these tests was 71 lbs.

Triple Valves.—The Westinghouse triples tested had been in use on the rack about three years, excepting one new valve which was taken at random out of stock. Seven New York triples tested were taken off cars, belonging to four different roads, just before the tests and four of the valves were taken off cars about 18 months previous to these tests, and had been in use on the rack before. All New York valves were type "C" triples and all but A, J and K were the latest pattern, having a 7-16-in. relief port, and stiff vent valve spring. When examined none showed wear and they had evidently seen little service, and all were in good condition. These New York triples will be referred to by letters A to K inclusive; B, C, D, E, F, G and H are those taken from cars expressly for these experiments; X, Y and Z are Westinghouse triples.

The code for testing triple valves, adopted by the M. C. B. Association, as recommended practice in 1895, was followed so far as could be done, considering that there was not a full rack of New York triples. A uniform train pipe pressure of 70 lbs. was used during the entire series of tests.

I. Application Test—Service.—The M. C. B. requirements are that with full service application and 6-in. piston travel, a brake cylinder pressure of about 50 lbs. shall be shown; the minimum pressure must not be less than 48 lbs., nor the maximum pressure over 52 lbs. This test is essentially a check on the proportion between the auxiliary reservoir and the brake cylinder and is not affected by the kind of triple or brake valve used. However, the brakes on cars Nos. 1, 2 and 3 were tested in this way, first with Westinghouse triples and then these were changed for New York triples. The train pipe pressure was 70 lbs. in all cases, while full service applications were made with the Westinghouse brake valve. The results of the tests with different piston travels are shown in table 1.

II. Application Test—Emergency.—In this test the 50-

EMERGENCY TESTS (III) WITH CARS CUT OUT.

Initial Reservoir Pressure, Lbs.	Triple Valves Cut Out. Westinghouse Car Nos.	Triple Valves Cut Out. New York Car Nos.	Brake Valve Used	Was Quick Action Secured?	Remarks.
		8-in. Piston Travel.			
a. First car Westinghouse triple; next, seven NewYork triples B, C, D, E, F, G and H; all others Westinghouse triples excepting cars Nos. 25, 26 and 27, which hadNew York triples I, J and K.					
70	1	2, 3, 7* and 27*	West	No.	New York triple just beyond gap. Three trials. Partial quick action on cars Nos. 4, 5 and 6; not sufficient to jump No. 7 cut out.
70	1	2, 3, 7* and 27*	New York	No.	Same as previous test.
b. Westinghouse triple here substituted for New York triple F on car No. 6 to determine if it would revive quick action sufficiently to cross car No. 7 cut out.					
70	1	2, 3, 7* and 27*	New York	Yes.	Two trials.
70	1	2, 3, 4, 7* and 27*	New York	Yes.	One trial.
70	1	2, 3, 4, 5, 7* and 27*	New York	Yes.	One trial. Westinghouse triple just beyond gap.
70	1	2, 3, 4, 5, 7* and 27*	West	Yes	One trial. Westinghouse triple just beyond gap.
c. New York triple A here substituted for New York G on car No. 7.					
70	1	2, 3, 4, 5, 6 and 27*	New York	No.	One trial. New York triple just beyond gap.
70	1	2, 3, 4, 5, 6 and 27*	West	No.	Two trials. New York triple just beyond gap.
d. New York triple G here substituted for Westinghouse on car No. 6.					
70	1	2, 3, 4, 5, 26 and 27	West	No.	Two trials. New York triple just beyond first gap.
70	1	2, 3, 4, 26 and 27	West	No.	Two trials. New York triple just beyond first gap.
70	1	2, 3, 26 and 27	West	No.	Two trials. New York triple just beyond first gap. Partial quick action on cars Nos. 4 and 5.
70	1	2, 3, 26 and 27	New York	No.	Three trials. New York triple just beyond first gap.
70	1	2, 26 and 27	West	No. Yes.	One trial. Two trials. New York triple just beyond first gap.
70	1	2, 26 and 27	New York	Yes.	Two trials. New York triple just beyond first gap.

*New York triple G, car No. 7, cut out on account of leaking through exhaust port; leak stopped later. New York triple K, car No. 27, cut out in all cases shown because of vent valve sticking open after emergency applications.

e. Same arrangement of triples as d.

70	..	2, 3, 4, 5, 26 and 27	West	No	Two trials. Westinghouse triple ahead, New York triple just beyond first gap.
70	..	2, 3, 4, 26 and 27	West	No.	Two trials. Westinghouse triple ahead, New York triple just beyond first gap.
70	..	2, 3, 26 and 27	West	Yes.	Two trials. Westinghouse triple ahead, New York triple just beyond first gap.
70	..	4, 5, 6, 26 and 27	West	No.	Two trials. New York triple ahead and just beyond first gap.
70	..	4, 5, 26 and 27	West	Yes.	Two trials. New York triples ahead and just beyond first gap.

f. Same arrangement of triples as d.

70	18, 19 and 20	26 and 27	West	Yes.	Three trials. Westinghouse triples just beyond gaps and ahead of first gap.
70	18, 19 and 20	25, 26 and 27	West	Yes.	One trial. Westinghouse triples ahead and just beyond gaps.
70	9, 10, 11, 18, 19 and 20	26 and 27	West	Yes.	Two trials. Westinghouse triples just beyond gaps and ahead of the second group.
70	9, 10, 11, 12, 18, 19 and 20	26 and 27	West	No.	Two trials. Quick action did not extend beyond car No. 8. Westinghouse triples beyond gaps, New York triples ahead of first and last gap.
70	10, 11, 12, 18, 19 and 20	26 and 27	West	Yes. No.	One trial. Two trials. Not beyond second group. Westinghouse triples beyond gaps and ahead of first and second gap.
		4-in. Piston Travel.			
Tests made to determine the effect of short travel. g. Same arrangement of triples as d.					
70	1	2, 3, 4, 5 and 27	West	No.	Three trials. New York triple just beyond gap.
70	1	2, 3, 4 and 27	West	No.	Three trials. New York triple just beyond gap.
70	1	2, 3 and 27	West	No.	Three trials. New York triple just beyond gap. Partial quick action on cars Nos. 4, 5 and 6.
70	1	2 and 27	West	Yes.	Three trials. New York triple just beyond gap. Note: New York triple A, car No. 7, failed to apply in these tests.
h. Same arrangement of triples as d.					
70	18, 19 and 20	26 and 27	West	Yes.	Three trials. Westinghouse triples just beyond gaps, and ahead of first gap.
70	17, 18, 19 and 20	26 and 27	West	No.	Three trials. Westinghouse triples just beyond gaps, and ahead of first gap.
70	9, 10, 11, 18, 19 and 20	26 and 27	West	Yes.	Three trials. Westinghouse triples just beyond gaps, and ahead of the second gap.
70	9, 10, 11, 12, 18, 19 and 20	26 and 27	West	No.	Three trials. Westinghouse triples just beyond gaps, and ahead of the second gap.
70	9, 10, 11, 16, 17, 18, 28, 29 and 30	....	West	No.	One trial. Westinghouse triples just beyond gaps. Failed to get quick action past New York triples on cars Nos. 25, 26 and 27.
70	9, 10, 11, 16 17, 18, 29, 30 and 31	....	West	No.	One trial. Westinghouse triples just beyond gaps. Failed to get quick action past New York triples on cars Nos. 25, 26 and 27.
70	9, 10, 11, 16 17 and 18	25 and 26	West	Yes.	One trial. Westinghouse triples just ahead of second and third and beyond first two gaps. New York triple just beyond third gap. Note: New York triple A, car No. 7, applied in these tests.

EMERGENCY TESTS (III) WITH CARS CUT OUT.—(Continued.)

Initial Reservoir Pressure, Lbs.	Triple Valves Cut Out. Westinghouse Car Nos.	Triple Valves Cut Out. New York Car Nos.	Brake Valve Used	Was Quick Action Secured?	Remarks.
		8-in. Piston Travel.			
i. Brake valve connected to rear end of rack making the first car what was before the fiftieth car. Car No. 50 had a Westinghouse triple and cars Nos. 49 to 42 had New York triples B, C, D, E, G, A and H respectively; all other cars had Westinghouse triples.					
70	40, 41 and 42	....	West	Yes.	One trial. Westinghouse triple ahead and New York triple just behind gap.
70	39, 40, 41 and 42	....	West	Yes.	Three trials got quick action on car No. 50, which had Westinghouse triple. Got partial quick action on intermediate cars having New York triples. Westinghouse triple ahead and New York triple just behind gap.
				No.	Three trials.
70	38, 39, 40, 41 and 42	....	West	No.	Two trials. Service back of group cut out. Westinghouse triple ahead and New York triple just behind gap.
j. Same arrangement of triples as i.					
70	50	45, 46, 47 and 48	West	Yes.	One trial. New York triples just ahead and just behind gap.
70	50	44, 45, 46, 47 and 48	West	Yes.	One trial. New York triples just ahead and just behind gap.
70	50	40 to 48 inclusive	West	Yes.	One trial. Westinghouse triple just ahead and New York just behind gap.
Note: Failed to get quick action with 10 cars cut out, Nos. 39 to 48, inclusive; Westinghouse triple ahead and New York triple behind gap. Got quick action in this series with nine cars cut out, with eight cars cut out, etc.					
k. Same arrangement of triples as i.					
70	..	40 to 49 inclusive	West	Yes.	One trial. Westinghouse triples ahead and behind gap.
Note: Failed to get quick action with 11 cars cut out, Nos. 39 to 48, inclusive; Westinghouse triples ahead and behind gap.					
l. Substituted here for New York triple F for the Westinghouse triple on car No. 50, and New York triples J, I and K replaced Westinghouse triples on cars Nos. 40, 41 and 42, respectively, making New York triples on the last 11 cars of the train.					

In this series of tests there were enough New York triples ahead of the cars cut out to fully eliminate any effects of the Westinghouse triples. The first test was made with eight cars cut out, Nos. 42 to 49 inclusive. but quick action was not obtained on the last car. The number of cars cut out was then decreased, cutting in one car at a time on the head end of the group. With three or four cars cut out, partial quick action was obtained on the last car; it requiring 5 4-5 seconds from the starting of the pointer of the fiftieth brake cylinder gage until full equalization of 50 lbs. was obtained in that cylinder. With a full service application it required from 6 2-5 to 7 1-5 seconds from the first movement of the gage pointer to full equalization on the fiftieth car. The term "partial quick action" here means that the vent valve of a New York triple is forced slightly from its seat discharging a comparatively small quantity of air from the train pipe to the atmosphere; in turn a few pounds of auxiliary air is suddenly vented into the brake cylinder through the emergency opening, equalization finally taking place through the graduating port. The amount of reservoir air vented into the brake cylinder through the quick action ports of the New York triple seemingly depends on the gap through which quick action jumps. It was noticed this amount varied from 10 lbs. partial quick action with cars cut out, to 40 lbs. where no cars were cut out.

With two cars cut out, Nos. 48 and 49, quick action was got on the last car; and also with one car, No. 49, cut out. In several of these last tests, the vent valve of New York triple valve K, on car No. 42, failed to close, and New York triple F on car No. 50 at times failed to release.

car rack was cut in behind a loop of 1-in. pipe, 65 ft. long, which corresponded to a locomotive and tender with the brakes cut out. On the first car was a Westinghouse triple, the next seven cars had New York triples, B, C, D, E, F, G and H in the order named, and all other cars had Westinghouse triples excepting cars No. 25, 26 and 27, which had New York triples I, J and K respectively. The intial auxiliary reservoir and train pipe pressures in all cases were 70 lbs. and the piston travel was 6 in. on all cars. The gages of cars Nos. 1, 25 and 50 were tested just before the trial to insure accurate readings. The time was taken with a split-second stop watch and the time record was not therefore so accurate as if electrical apparatus had been used, but errors in time are doubtless small. The time readings were taken from the first movement of the engineer's brake valve handle until full equalized pressure was reached on the fiftieth car. The results of these tests are shown in table 2.

Table 2.—Application Tests—Emergency.

No. of trial.	First car. Max. pressure, lbs. Westinghouse triple.	Twenty-fifth car. Max. pressure, lbs. New York triple.	Fiftieth car. Max. pressure, lbs. Westinghouse triple.	Time, Seconds.
	Westinghouse Brake Valve.			
1	60	49½	59½	3⅕
2	61	50	61	3⅕
3	62½	50½	60½	3
4	62	50	60½	3⅕
These tests were duplicated by cutting out the Westinghouse brake valve and using the New York brake valve; all other conditions the same.				
	New York Brake Valve.			
1	62	50½	61½	3
2	61½	50	60½	3
3	62	50	60½	3⅕
4	61½	50	60½	3⅕

The M. C. B. code covering these tests requires a final maximum brake cylinder pressure of not less than 15 per cent., nor more than 20 per cent. above the pressure given by the same brake in full service applications. The maximum and minimum allowable brake pressures in full service application are 52 and 48 lbs. respectively, which as a basis would make the lower allowable pressure in this test 55.2 and the higher limit 62.4 lbs.

It will be noted that while the Westinghouse triples meet these requirements the New York valves give a final pressure of about 50 lbs. in all cases, and this is due to the fact that New York triples vent air from the train line to the atmosphere, and necessarily can not give any increased brake cylinder pressure over that got in full service.

III. Application Test—Cutting Out Cars.—The conditions were the same as in series II, excepting that the piston travel in most instances was nominally 8 in. on all cars; otherwise 4 in. on all cars. The initial reservoir pressure was 70 lbs. The table (pp. 382 and 383) gives the results of emergency tests with various groups of cars cut out in different parts of the train.

These tests brought out a number of interesting points, which account for the large number of trials made under different conditions. Series a and b indicate that, where the Westinghouse and New York valves are used together in the same train, the Westinghouse triples act to revive quick action which has partially expired by passing a group of New York triples. In this particular instance the first three cars and the seventh car were cut out, and with all New York triples acting up to the ninth car, only partial quick action could be got on cars Nos. 4, 5 and 6, while quick action did not extend past car No. 7, cut out. By simply replacing the New York triple on car No. 6 with a Westinghouse triple, it was not only possible to get quick action under these same conditions, but quick action was got with the first five cars cut out. This same thing was brought out in connection with other tests; that Westinghouse triples may act to revive quick action which would not be carried through to the end of the train by the New York triples alone.

With a group of eight New York triples at the head end of the train it was not possible to get quick action on the rear cars with more than the first two cars cut out; in the same position quick action was obtained with a Westinghouse triple on the sixth car, all ahead being cut out. In the middle of the train, with Westinghouse triples, quick action could be got through one and two groups of three cars cut out, and in series h quick action jumped two cars cut out, with a New York triple on the far side of the gap.

With New York triples on the last 11 cars of the train, quick action would jump but two cars cut out. Using Westinghouse triples, quick action was got with 10 cars cut out just ahead of the last car. In series j, it will be noted that a Westinghouse triple was on the ninth car from the rear end of the train and under these conditions quick action was got with a New York triple on the forty-ninth car with the nine cars just ahead cut out. In view of the very different results of series k, where the Westinghouse triples were farther removed from the gap, it is possible that the Westinghouse triples had some effect on the results of series j.

It will be seen from series g, that these emergency application tests are not materially affected by a difference in piston travel from 8 in. to 4 in.

IV. Graduating Test (A).—This series of tests was made with 70 lbs. train pipe pressure and the full 50-car rack; the Westinghouse brake valve was connected at the rear of the rack, bringing 11 New York triples at the rear of the train. These New York triples were on cars Nos. 40 to 50 inclusive and were arranged in the following order: B, I, K, H, A, G, F, D, C, J and E, the last car of the train. The piston travel on all cars was 6 in.

In each of the three trials an 8-lb. reduction of train pipe pressure applied all the brakes lightly and a further reduction of 5 lbs. set the brakes on all cars more fully. A further reduction, making the total reduction 30 lbs., equalized the pressures between the auxiliary reservoirs and the brake cylinders, as specified in the M. C. B. code on cars fitted with either Westinghouse or New York brakes.

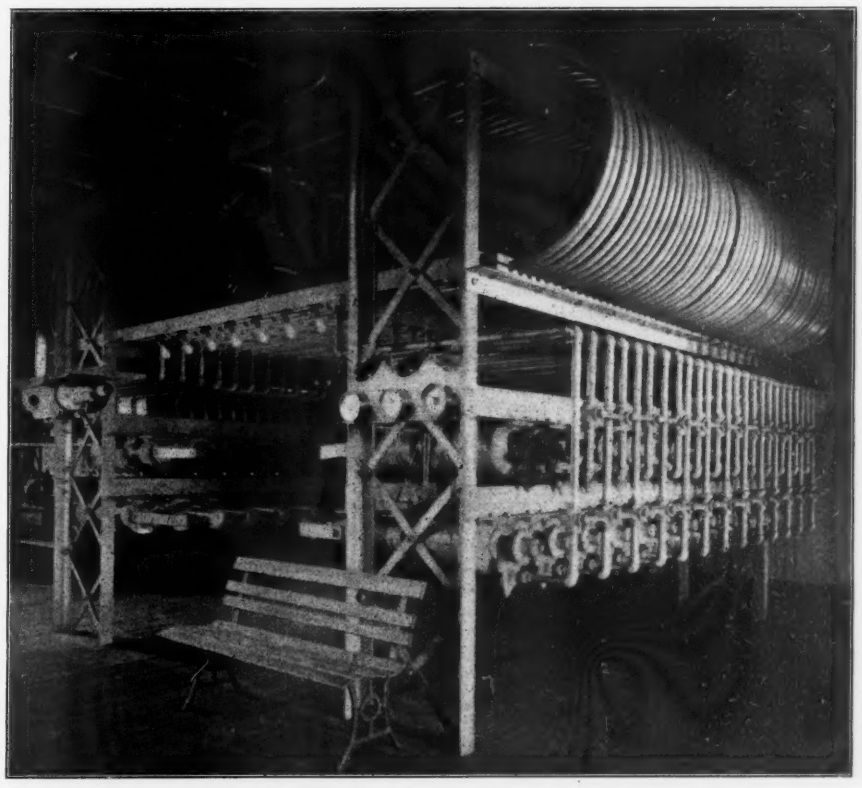


Fig. 1.—Brake Rack of the American Brake Company, at St. Louis, Mo.

(*B*). Further graduating tests were made with New York triple E and Westinghouse triple X on the first car of the rack. The piston of the brake cylinder was removed and a head substituted which made the brake cylin-

der a tight reservoir with a volume equal to that of a brake cylinder with 8-in. stroke. The first addition to the cylinder was made with a reduction of train pipe pressure of 5 lbs., followed by a series of reductions, each of which reduced the auxiliary reservoir pressure about 3 lbs. The equalized pressures in the several trials were as in table No. 3.

Table No. 3.

	1.	2.	3.
New York triple E.....	52 lbs.	53½ lbs.	53½ lbs.
Train pipe pressures at full equalization	50 lbs.	50½ lbs.	51 lbs.
Westinghouse triple, X....	54 lbs.	53 lbs.	53 lbs.
Train pipe pressures at full equalization	52 lbs.	50 lbs.	51 lbs.

V. Tests to Determine the Sensitiveness of the Service, and (VI) the Quick-Action Features.—Three Westinghouse and four New York triples were subjected to these tests. The piping represented the locomotive and tender, with brakes cut out, and one car, upon which all the triples were tested in accordance with the M. C. B. requirements. The initial train pipe pressure in all tests was 70 lbs. The required openings in the engineer's valve were secured by means of the fitting shown in Fig. 2. This fitting screws into the bottom cap of the Westinghouse brake valve and air can be discharged from the train line through different size openings varying by 1-64 in., from 1-64 to 15-64 in. in diameter. A separate disc is provided for each opening. The engineer's brake valve in these tests was used simply for recharging the train pipe and separating the train pipe from the main reservoir pressure.

The M. C. B. requirements in the test of the service feature (V) are that service action must take place and continue to take place without any appearance of quick action when air is discharged from the train pipe through an opening 2-64 to 3-64 in. in diameter, and so continue until the opening has been enlarged up to and including a 10-64 in. opening. (VI). Full quick action must not take place before 11-64 in., but must take place when the opening is 14-64 in. in diameter. The results of these tests are as in table No. 4, three or more trials being made under the same conditions.

TABLE NO. 4.

Diameter of Opening. In.	Westinghouse Triple Valves. X.	Y.	Z.	New York Triple Valves. B.	C.	E.	H.
2-64	Service	Service	Service	Service	Service	Service	Service
3-64	Service	Service	Service	Service	Service	Service	Service
10-64	Service	Service	Service	Service	Service	Service	Service
11-64	Service	Service	Service	Service	Service	Service	Service
12-64	Service	Partial q. a.	Service	Quick action	Service	Service	Service
13-64	Quick action	Quick action	Quick action		Quick action	Service	Service
14-64	Quick action	Quick action	Quick action		Quick action	Service	Partial q. a.
15-64						Service	
16-64						Quick action	

Westinghouse triple X was new, just taken out of stock, and Y and Z had been used on the rack for about three years but were clean. New York triple B was tested just as taken from the car, the date of last cleaning being July, 1899; New York triples C, E and H were cleaned and oiled just before this test. It will be seen that both the Westinghouse and New York triples met the requirements, excepting where New York triple E did not give quick action with the 14-64-in. opening.

VII. Holding Power in Service Application.—In these tests the full 50-car rack was used with the New York triples at the rear, the arrangement of triples being the same as in the Graduating Test (IV). The piston travel was 6 in. The brakes were applied by making the pressure in the first brake cylinder about 15 lbs., gages on the first, twenty-sixth and fiftieth cars being read at the time of application and after 5, 10 and 15 minutes respectively. The results of the two trials made were as in the table.

In making this test it was found that the gradual reduction of train pipe pressure, due to leakage, caused the brakes to apply until full on.

VIII. Release Test.—To determine the train pipe leakage a small reduction was made in the train pipe pressure sufficient to close the feed ports and prevent back leakage from the auxiliary reservoirs, and with the brake valve and main reservoir cut out, it was found that the train pipe pressure reduced about 1 lb. in 1½ minutes. In making the release test, a uniform train pipe pressure of 70 lbs. having been secured, all the air was exhausted from the train pipe by a quick action application and then a main reservoir pressure of 90 lbs. was maintained for 30 minutes against a diaphragm perforated by a 3-32 in. hole, arranged as shown in Fig. 3.

In the first trial New York triple K, car No. 27, was cut out on account of the vent valve sticking open after most emergency applications. New York triple G, car No. 7, failed to apply in the quick action application, thus making 8 New York triples in the first trial and 40 Westinghouse triples. In the first trial the 8 New York brakes released within 30 minutes and all the 40 Westinghouse brakes, excepting Nos. 23, 30, 41 and 50; 10 per cent. of the Westinghouse brakes remaining applied.

In the second trial all of the 50 cars were cut in and the vent valve of New York triple K, car No. 27, stuck open after the emergency application, but the discharge of air was almost instantly stopped by quickly closing and opening the cut-out cock. New York triple G, car No. 7, failed to apply. Nine New York brakes were thus involved in the second trial and 40 Westinghouse. The New York brake on car No. 27 failed to release in 30 minutes, and also the Westinghouse brakes on cars Nos. 23, 30 and 41.

HOLDING POWER IN SERVICE APPLICATIONS (VII)—PRESSURES IN LBS.

	At Application.		After 5 Minutes.		After 10 Minutes.		After 15 Minutes.	
	Brake Cyl.	Aux. Res.	Brake Cyl.	Aux. Res.	Brake Cyl.	Aux. Res.	Brake Cyl.	Aux. Res.
First trial:								
First car— Westinghouse triple	15	63	52	52	41	41	36	36
Twenty-sixth car— Westinghouse triple	12	63	37	53	42	42	36	36
Fiftieth car— New York triple, E.....	16	63	39	54	41	41	36	36
Train pipe		63		50		40		37
Second trial:								
First car— Westinghouse triple	16	63	53	53	43½	43½	42	42
Twenty-sixth car— Westinghouse triple	12	63	34	53	44	44	44	44
Fiftieth car— New York triple, E.....	20	63	40	53	44	44	42	42
Train pipe		63		53		45		37

Note: No. 1 equalized in 5½ minutes, and Nos. 26 and 50 in 8 minutes. New York triple J, car No. 49, released normally in 1¾ minutes.

Note: No. 1 equalized in 4 minutes 50 seconds at 53 lbs., and Nos. 26 and 50 both equalized at 47 lbs. New York triple J, car No. 49, released normally in 1¼ minutes.

New York triple G, car No. 7, failed to apply on the third trial and the vent valve of triple K, car No. 27, acted as in the previous test. The New York brake on car No. 27 failed to release in 30 minutes, as also the Westinghouse brakes on cars Nos. 23 and 42. Within the first 5 minutes, 12 Westinghouse and 4 New York brakes released; 16 Westinghouse and 2 New York brakes released in the second 5 minutes; in the third interval 6 Westinghouse and 2 New York brakes released; in the fourth interval 3 Westinghouse released and during the fifth 5-minute interval 1 Westinghouse brake released.

In the fourth trial, the first 11 cars of the rack (but the last cars of the train) were New York triples and all others were Westinghouse; couplings were changed so as to put the brake valve at the rear of the rack. All brakes applied, but New York triples A and K released at once, but not normally; these as well as New York triple H leaked through the exhaust and had to be cut out. All New York brakes released within thirty minutes, and all but three Westinghouse brakes released; these were on cars Nos. 28, 21 and 9, being cars Nos. 23, 30 and 42, counting from the head of the rack. Nine Westinghouse and 2 New York brakes released in the first 5 minutes; 15 Westinghouse and 7 New York in the second interval; 9 Westinghouse and 2 New York in the third interval; 2 Westinghouse in the fourth interval and 1 Westinghouse brake released in the fifth 5-minute interval.

In no case did more than 10 per cent. of the Westinghouse brakes fail to release. A greater proportion failing to release is held to be unsatisfactory by the M. C. B. code.

IX. Time of Charging One Auxiliary Reservoir.—The same triples were used in this test as in V and VI and the auxiliary reservoir of car No. 1 was used in all trials, three or more tests being made with each triple. In all cases the first brake being cut out, the reservoir was bled, the car cut in and then the time of charging to 70 lbs. was taken by means of a split-second watch, the pressure in the main reservoir and train pipe being maintained at 90 lbs. The M. C. B. requirements are that the time of charging shall not be less than 45 seconds, nor more than 60 seconds. The results are shown in table 5.

Westinghouse triple X was new, just taken out of stock, and Y and Z had been used on the rack for about three years, but were clean. New York triple B was tested just as taken from the car, the date of last cleaning being July, 1899; New York triples C, E and H were cleaned and oiled just before the tests. The Westinghouse and two New York triples stood the charging test, while two New York triples failed to charge the auxiliary reservoir in 60 seconds; one of these, B, as stated before, had not been cleaned since its removal from service and was tested simply as a matter of interest.

Table No. 5.

Name of Triple Valve.	Time to Charge Auxiliary Reservoir. Seconds.	Average Time. Seconds.
Westinghouse, X....	60; 56 2-5; 59 3-5 and 58 3-5	58 3-5
Westinghouse, Y....	54 1-5; 56 4-5 and 55 2-5	55 2-5
Westinghouse, Z....	56; 56 3-5 and 56 1-5	56 1-5
New York, B.....	78; 76 3-5 and 74	76 1-5
New York, C... ...	67 2-5; 67 3-5 and 67	67 2-5
New York, E.....	57; 58 1-5 and 58 2-5	57 4-5
New York, H.....	52 2-5; 56 1-5 and 59	55 4-5

X. Quick Action After a Service Application.—In these tests a pressure of 20 lbs. was got in the first brake cylinder by a service application and was followed by a full emergency reduction. Under these conditions the M. C. B. code states that quick action should take place. The pressure obtained in the first brake cylinder, by the service application, was decreased in subsequent tests by steps of 5 lbs. each, to determine, if need be, at what point quick action commences for the two kinds of triple valves, after once moving into service position. The initial auxiliary reservoir pressures were 70 lbs. and the piston travel was nominally 8 in.

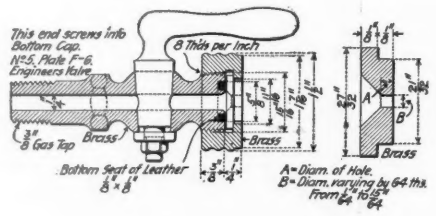

This end screws into Bottom Cap. No. 5, Plate F-6, Engineers Valve.
8 Thds per Inch
Brass
Brass
Brass
Bottom Seat of Leather
A=Diam. of Hole.
B=Diam. varying by 64 ths. From 1/64" to 15/64"

Fig. 2—Discharge Valve.

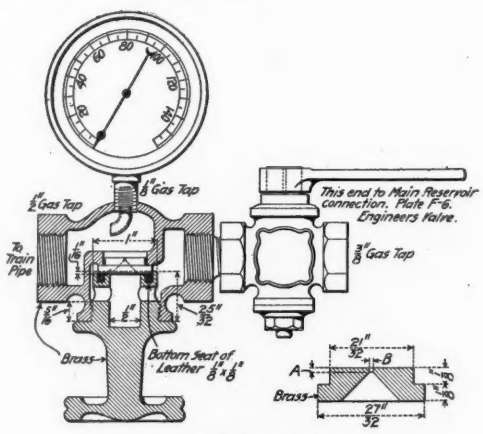


Fig. 3—Feed Valve.

Special Attachments—Westinghouse-New York Brake Tests.

In the first trials, the Westinghouse brake valve was connected to the rear of the rack bringing most of the New York triple valves near the rear of the train. New York triple valves were on two cars, Nos. 24 and 25, and New York triples were on seven cars, Nos. 43 to 49 inclusive. All other brakes were Westinghouse. In these tests, starting with a pressure in the first brake cylinder of 20 lbs., quick action did not extend beyond car No. 23, just ahead of the first New York triples; four trials gave the same results.

To determine whether this was due to the New York triples on cars Nos. 24 and 25, these valves were replaced by Westinghouse triples. And all the New York brakes were put at the rear of the train. The arrangement of

the rack was then all Westinghouse triples up to car No. 40, that and the other cars having New York triples were arranged in the following order: B, I, K, H, A, G, F, D, C, J and E on the last car. Gages were put on the brake cylinders of the last Westinghousecar car and on the first New York car in addition to the gages of the first, last and middle car of the rack.

In the next series, the pressure in the first brake cylinder was 20 lbs., followed by an emergency application. In three trials, quick action was got on all cars up to and including No. 39, the last one with Westinghouse brakes, while the New York brakes did not give quick action. The same results were obtained by making emergency applications after pressures of 15, 10 and 5 lbs. respectively had been obtained in the first brake cylinder by service applications. That is, in no case did the Westinghouse brakes fail to give quick action after service applications, while in no case did the New York brakes give quick action after service applications.

During the first tests, with 20-lbs. brake cylinder pressure, New York triple K on car No. 42 failed to apply after either a service or emergency application and in other trials it applied slowly during the emergency application, afterward failing to release; in one case it failed to apply during the service application but gave quick action in the emergency application and released immediately. New York triple J on car No. 49 also acted in an erratic manner, in most cases failing to apply.

These same tests were repeated with the brake valve so connected as to bring the New York triple valves all at the head of the train and immediately behind the tender. In none of these tests, starting from pressures in the first brake cylinder of 20, 15, 10 and 5 lbs. respectively, did quick action take place on the first or other cars of the train; the New York triples when placed immediately behind the locomotive preventing quick action after service applications. Other tests showed that the same results were obtained if groups of two or more New York triples were placed at interrnediate points in the train between Westinghouse triples.

Miscellaneous Test.—A. To show the effect of leaks past check velves in the New York triples some miscellaneous tests were made. A leak was made past the check valve between the brake cylinder and chamber "L" of the New York triple on car No. 3; a leak was also made past the quick action check valve of the New York triple on car No. 2. Trials were first made with a 9-car train having a Westinghouse triple on the first and ninth cars between which were 7 New York triple valves. The piston travel was 8 in. and the auxiliary reservoir pressures 70 lbs. The Westinghouse brake valve was used.

Car No. 2 cut out:

a. Made a 10-lb. reduction of train pipe pressure and all brakes applied and No. 3 leaked off, the air passing out through the vent ports.

b. Made a 25-lb. reduction of train pipe pressure. Brakes applied and No. 3 leaked off, the same as in the previous test.

c. Made an initial reduction of 6 lbs., followed by further reductions, and No. 3 leaked off as before. New York triple H, car No. 8, released normally after each application, when the brake valve handle was placed on lap. There was no apparent reason for the release of No. 8, as up to this time the brake had been working properly.

All nine cars cut in:

a. Made a series of small reductions, in all reducing the train pipe pressure 10 lbs. Car No. 2 did not apply, there being no pressure in the auxiliary reservoir of that car on account of leak past the quick action check valve, as rapidly as it was fed in through the feed port. Car No. 3 applied and released. Car No. 2, while not itself applying, took air from the train pipe, being in effect a train pipe leak, and set all brakes fully, excepting car No. 3.

b. Made a 5-lb. reduction and put the brake valve handle on lap. Car No. 3 was fully off in 14 seconds. Car No. 8 released normally and applied again later. All brakes, except car No. 2, fully applied on account of the leak in car No. 2 in 2 min. 20 sec.

c. With the first four cars only working, a 5-lb. reduction was made. No. 2 did not apply. No. 3 applied and went off immediately.

(B.) With the same train of four cars the train pipe and main reservoir pressures were both brought to 70 lbs. Then a 5-lb. reduction was made, the brakes were released and the brake valve handle put in the running position. When this was done using the New York brake valve, car No. 2 did not apply and No. 3 went off immediately after the first reduction was made. After the New York brake valve was put in running position, the good brakes applied, but when the same operation was performed with the Westinghouse brake valve, the brakes were kept off; showing the advantage of the Westinghouse feed valve attachment as compared with an excess pressure valve.

(C.) A trial was made to determine the action of the New York triple if the small port (F) through the vent valve piston should become stopped up in service. This hole was plugged with solder and the valve put on car No. 5 of a 10-car train with all New York brakes. It was found that under these conditions the plugged triple would give quick action and then immediately release when the train pipe pressure was reduced from 4 to 5 lbs. in a service application; the same results were obtained with a 5-car train. When used with 50 cars, the triple with the plugged piston did not give quick action. With the short trains quick action was not got on the other cars because with the New York triples quick action can not be obtained immediately after a service application; such a defective valve in a train of Westinghouse brakes, however, would start quick action on the other cars.

On the other hand, wear of the packing about the vent valve piston of the New York triple is equivalent to increasing the size of the port hole (F), and a small leak past this packing is sufficient to prevent the working of the quick action of the triple.

(D.) This was a comparative test to determine the effect of a fixed leak through an opening, 1-64 in. in diameter, from the equalizing reservoir of the Westinghouse brake valve, and the same size leak from the supplementary reservoir of the New York brake valve; both brake valves being handled according to the instructions of the makers.

In the first trials the Westinghouse brake valve was used with a 4-car train, the train pipe and auxiliary reservoir pressures were 70 lbs. and a leak was made by inserting a diaphragm with a 1-64-in. opening in the piping to the equalizing reservoir. A 5-lb. reduction of train pipe pressure was made and the brake valve handle moved to the lap position. In one minute, the train pipe pressure reduced from 65 to 60 lbs. Two other trials gave the same results.

The New York brake valve was tried under the same conditions, the diaphragm with 1-64-in. opening being placed in the piping to the supplementary reservoir. A 5-lb. reduction was made and the hand removed from the brake valve. This valve is intended to lap automatically which it would have done had it not been for the fixed leak; that being the only defect in the valve or piping. In all trials, train pipe pressure was reduced by air escaping through the service application port and supplementary reservoir pressure was reduced by the leakage through the fixed opening. In the first trial the train pipe pressure fell from 65 to 9 lbs. in one minute; in the second trial from 65 to 29 lbs. in ½ minute and to 9 lbs. in 1 minute; in the third trial train pipe pressure dropped from 65 to 17 lbs. in one minute and in the fourth trial from 65 to 18 lbs. in one minute.

Making a 5-lb. reduction and handling the New York brake valve as before, in three trials, all brakes were fully applied in 10 4-5, 11 3-5 and 11 seconds respectively. The time readings were commenced when the train pipe gage showed 65 lbs. pressure. Using the Westinghouse brake valve and returning the handle to the lap position, after a 5-lb. reduction, the train pipe pressures at the end of 1 minute were 61 and 60½ lbs. respectively, in two trials.

These tests show that with a small leak in the supplementary reservoir of the New York brake valve the automatic lap feature is destroyed and the brake valve must then be handled in a different manner from that prescribed by the maker; a corresponding leak with the Westinghouse brake valve does not interfere with its being operated in the usual way.

(E.) Test to determine the sensitiveness of the Westinghouse triple to quick action. In order to determine what effect short travel might have on the quick action feature of Westinghouse triples, the pistons of cars Nos. 13 to 24 inclusive were blocked to about 1-in. travel. It was found that quick action prevailed on the fiftieth car. The pistons of cars Nos. 13 to 24 inclusive were then blocked solid and quick action prevailed on the fiftieth car. This test shows the sensitiveness of the Westinghouse triples: the volume of the tube in the auxiliary reservoir and the clearance space in the brake cylinder being sufficient to trip quick action on succeeding car.

Acetylene Gas for Car Lighting.

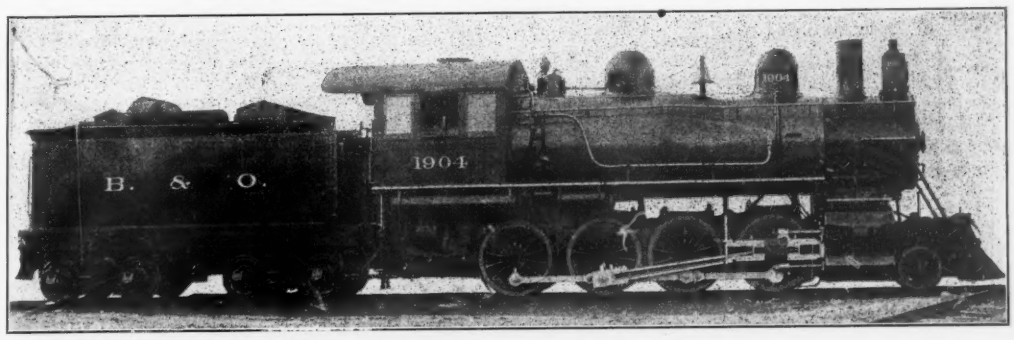
So far railroads have taken but little interest in acetylene gas for passenger car lighting, and have been content to wait for the results of experiments in lighting houses and buildings. In this field there has been a good many failures, largely due to apparatus being installed and handled by incompetent people, and, on the whole, it is doubtful if the experience so far gained in any way indicates the possibilities of acetylene gas. A few roads, however, are now taking up the question of acetylene lights in an experimental way, notably the Chicago, Milwaukee & St. Paul, and it has been determined that this method of lighting cars has some attractive features, chiefly that of low cost and superior quality of the light. It is not to be understood that the success of acetylene lights is yet assured, but merely that some of the difficulties have been overcome, and the others, so far as known, do not appear insurmountable.

The St. Paul has experimented in the laboratory with three forms of gas generators, each of sufficient capacity for lighting one car, and these generators will cost from $50 to $75 each. It is found that, to furnish lights for one car for 18 hours, about 30 pounds of calcium carbide is needed and 14 gallons of water, and the whole outfit will weigh about 300 pounds. Based on these experiments, the cost of lighting passenger cars with acetylene gas, on a candle-power basis, is practically the same as lighting through trains by electricity supplied from a generator in the baggage car, and the St. Paul has found that electricity generated in this way is the cheapest means of lighting through trains when the cost of candle-power is made the basis for comparison. Further, the laboratory experiments indicate that it is practicable to light cars by acetylene gas generated on the car, so as to make each car a separate unit, and here is the chief advantage over lighting by electricity generated at the head end of the train. The gas generator will take up some space in the car, possibly requiring some rearrangement at the ends, and precautions will have to be taken against the generators freezing when cars are cut out in cold weather. The first, which may be considered an objection, is not a serious matter, and the freezing of the generator may be overcome by draining the apparatus when cars are cut out for long periods. It is believed that there are no objections to a well-designed generator on the score of safety. It is proposed to supplement the laboratory experiments with service trials of the apparatus on cars.

Compound Consolidation Locomotives for the Baltimore & Ohio.

[WITH AN INSET.]

The accompanying engravings show the important features of the new compound consolidation locomotives built by the Baldwin Locomotive Works for the Baltimore & Ohio, and one of the interesting things in connection with these engines is the large number built from a single design. It was at first thought that 165 engines for the Baltimore & Ohio, 60 for the Union Pacific and 10 for the Kansas City, Pittsburgh & Gulf would be identical, but after making the original contract 24 engines of the Baltimore & Ohio were changed to have Wootten boilers and two to have the Vanderbilt boilers, with cylindrical corrugated firebox. The 60 engines for the Union Pacific were changed to straight top instead of wagon top boilers, and a deckplate was added back of the firebox; also two of these will have Vanderbilt boilers. Some modifications have also been made in the ten engines for the Kansas City, Pittsburgh & Gulf to suit the practice of that road, but in the main the engines are alike, the cylinders, frames, valve motion, running gear, etc., being duplicated throughout the entire lot of 235 locomotives.



Compound Consolidation Locomotive, Baltimore & Ohio R. R.

Built by the BALDWIN LOCOMOTIVE WORKS, *Philadelphia, Pa.*

These are unusually large for road engines, having cylinders 15½ and 26 in. x 30 in., driving wheels 54 in. in diameter with journals 9 x 10 in., a working steam pressure of 200 lbs., and 163,330 lbs. on the drivers; the total weight in working order is 182,330 lbs. and the tender loaded weighs 100,000 lbs. and has a capacity for 5,000 gallons of water. The engravings refer particularly to the Baltimore & Ohio engines.

The boiler, the details of which are shown, is of the radial stay, extended wagon top type with the firebox above the frames. The heating surface of the firebox is 179.5 sq. ft., that of the tubes 2142.9 sq. ft., and of the water tubes supporting the brick arch 25.1 sq. ft., making a total heating surface of 2347.5 sq. ft.; the grate area is 33.7 sq. ft. The diameter of the boiler shell at the front is 64 in. and there are 244 iron tubes, 2¼ in. in diameter and 14 ft. 10½ in. long. The details of the boiler are clearly shown by the engravings. The firebox is 9 ft. 10 in. long by 3 ft. 5⅛ in. wide and varies in depth from 67⅛ in. at the front to 70⅛ in. at the back. It will be noted that the upper row of stay bolts and the stay bolts in the upper corners, front and back, are 1⅛ in. in diameter, while the others are 1 in. in diameter; all have a 3-16-in. hole, 1¼ in. deep in the outer end to indicate when bolts are broken in service.

The cylinders and piston valve chamber are given in detail, the low-pressure cylinder being above, with its center line 2 in. inside the center line of the high-pressure cylinder. The turning effect thus set up at the crosshead is resisted by an additional bearing which the crosshead has on the outside surface of the guide bars. The valve chamber is between the front rails and the valve rod proper is short. As shown, a bar passing beneath the forward driving axles transmits motion to a hanger to which the valve rod is attached. The frames are of cast steel and the cylinder fastenings, also shown by detail drawings, are made unusually strong. In addition to an upper and lower rail,

there is a third rail 10 in. inside the main frames and joined to the others at the front, and this bar extends under the cylinder saddle and alongside the valve chamber. The main driving wheel centers are cast steel and the other centers are cast-iron.

The special equipment includes: Westinghouse air brakes, Detroit lubricators, Shea sanding devices, Monitor injectors, and U. S. Metallic packing for piston rods and valve stems.

New 80,000-lb. Coal Cars—Norfolk & Western Railway.

The effects on the sides and floors of all-steel coal cars of the acids and moisture in coal are being more or less realized, and in some cases these parts have been seriously damaged in less than two years service. A few railroads, anticipating this trouble, have used a wood lining and floor with metal underframes, and this practice promises to receive more attention in the near future. As examples of using wood for the upper work of coal cars, there may be mentioned those designed by Mr. E. M. Herr, while on the Northern Pacific*, the Norfolk & Western hopper bottom cars† and the cars now building for the Philadelphia & Reading‡, besides which a number of plans have been made to use metal underframes with wood sides and floors which have not yet been carried out.

The New Norfolk & Western Coal Car.

Capacity, 80,000 lbs. Designed by C. A. Seley, M. E.

This feature is also present in the new sample drop bottom coal car of the Norfolk & Western, designed by Mr. C. A. Seley, Mechanical Engineer of the road, and shown in this issue. In this car advantage has been taken of the full, high sides to use a truss of rolled shapes which dispenses with the usual stakes and stake pockets and permits a light side sill to be used. In this case, the use of the trussed side made the weight of the car almost 1,200 lbs. lighter than it would have been had the sides been supported on steel sills and held by stakes and pockets. Also, it is reasonable to think, in the absence of information to the contrary, that the trussed wooden side is not only cheaper than an all-steel construction, but cheaper than stakes, pockets and heavy side sills. The light weight of the sample car when used with 80,000-lb. capacity trucks will be about 32,000 lbs.

The length of this car over buffer beams is 36 ft. 6½ in.; over end sills 35 ft. 1 in., and inside the box 33 ft. The width over side sills is 9 ft. 1 in. and inside the box 8 ft. 9½ in. The sides are 4 ft. 6 in. high. All the metal used is in the form of standard rolled sections, regular size bars or plates, no special or unusual sizes being used. All attachments, such as drop door hinges, cross sill supports, and for the brake fixtures are riveted on.

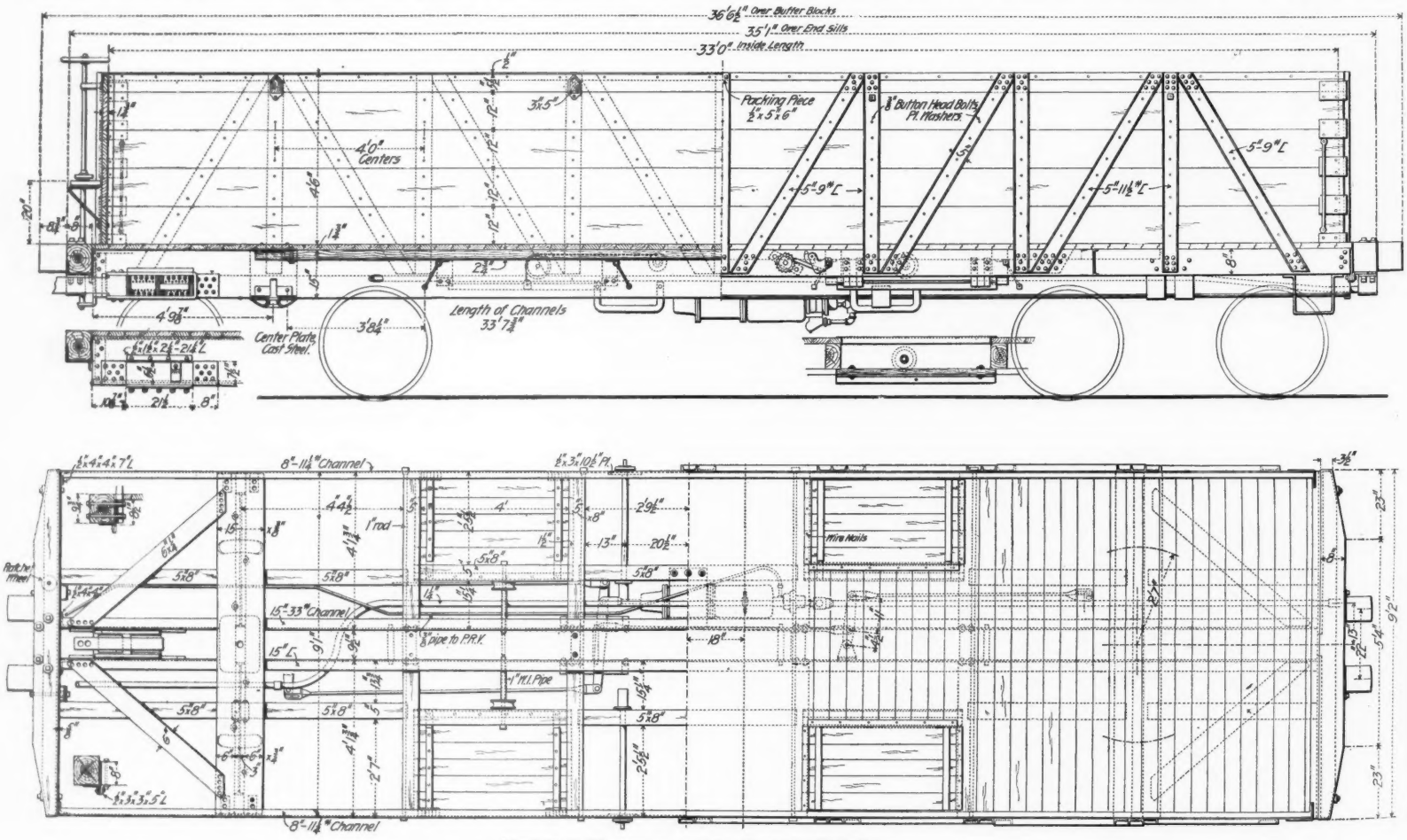
The center sills are 15-in. 33-lb. channels, joined to the end sill plates and body bolster members by angle irons, and the full strength of the flanges of the channels has been preserved by making all holes for connections through the webs of the channels. The side sills are 8-in. channels. In order to provide door pockets and intermediate floor supports, a system of short intermediate sills and cross sills is used, the cross sills being grooved for 1-in. through tie rods. The lining and flooring are of pine, 1¾ in. thick. Owing to the height of the sides and the lateral pressure of coal as lading, four top cross tie rods are used to prevent bulging; these, however, will not prevent using the car for lumber. Four drop doors are provided, which are handled by winding shafts, chains, ratchets and locks, in the usual way, the doors being so placed as to dump a large proportion of the contents of the car.

The side truss members are 5-in. channels of such weight as is required by the loads at the various panels, taking also into account the strength required to resist the lateral thrust of the lading. The bottom chord or side sill is an 8-in., 11¼-lb. channel; the top chord is a heavy angle, and gusset plates ½ x 6 in. are used for the upper connections. The top angle also serves as a coping for the wooden lining of the car.

The body bolsters consist of steel plates and malleable iron fillers, riveted in such a way as to secure the necessary rigidity with light weight. The car is equipped with Westinghouse air brakes, the design of the underframing permitting a very simple and direct brake system. The couplers are arranged with tandem springs, the draft lugs being riveted directly to the center sills.

The sample car, as shown, is mounted on a pair of trucks, standard to the 100,000-lb. capacity cars of the Norfolk & Western, as at the time this car was built the standard 80,000-lb. truck had not been designed. With these heavy trucks, the weight of the car is 33,700 lbs., but with the new trucks since designed, this weight will be reduced to 32,000 lbs., or less.

The new truck is shown by the engravings, and is similar in many respects to those used with a large part of the Norfolk & Western cars. It has 6-in. less wheel base than the 100,000-lb. truck, and this feature admits of the use of lighter arch bars. The bolster, spring plank and other details have also been lightened where consistent with good design. The journals are 5¼ x 9 in., the same as are in use under 100,000-lb. capacity cars, and, although not M. C. B. standard for that weight, have nevertheless given satisfactory service. This car was designed for a lading of 88,000 lbs., with not to exceed 10,000 lbs. per sq. in. fiber stress in the various members. The test load of the sample car was wet coal and weighed, when well heaped, 92,700 lbs. This was subsequently increased by heavy rains to 95,250 lbs., and under this load the deflection of the center sills was a full ¼ in., and that of the side sills was a scant ⅛ in. Since the car has been in regular service, it has been noted that the lading averages the rated amount of 88,000 lbs. The car has a very neat, trim appearance, and its service test has so far been very satisfactory. The Norfolk & Western is preparing to build 1,000 cars similar to this sample in the near future; or as soon as the present lot of 100,000-lb. cars, now nearing completion, is finished.

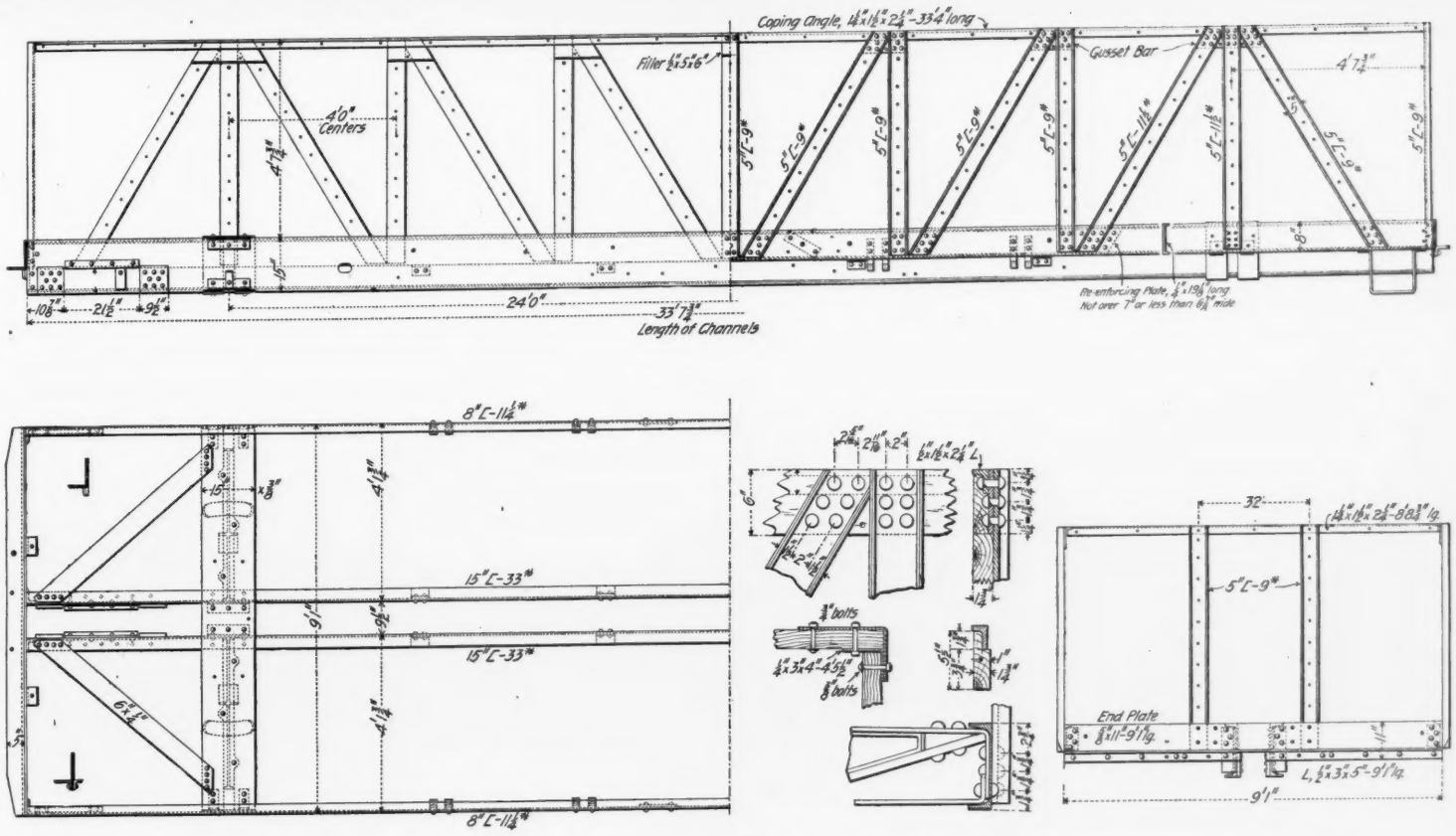


Norfolk & Western 80,000 lbs. Capacity Coal Car.

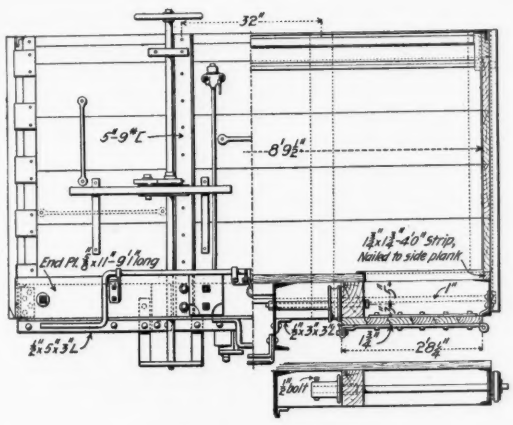
Railroad Gazette, Sept. 23, 1898.
†*Railroad Gazette*, July 28, 1899.
‡*Railroad Gazette*, April 27, 1900.

Some Elements of Modern Shop Arrangement.

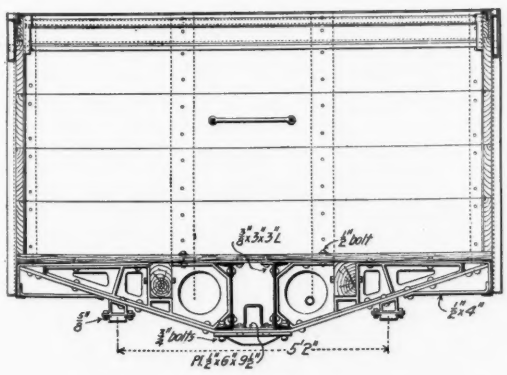
With prosperous times, large increase of rolling stock, the necessity for low cost of repairs, as well as actual pressure for more shop room, many of the railroads will soon build new repair shops. In fact, several railroad shops on a large scale are now under way. We may, therefore, profitably consider some of the elements which should enter into the construction of modern railroad



Norfolk & Western 80,000 lbs. Capacity Coal Car—Elevations, Sections and Details.



Sections and End View.

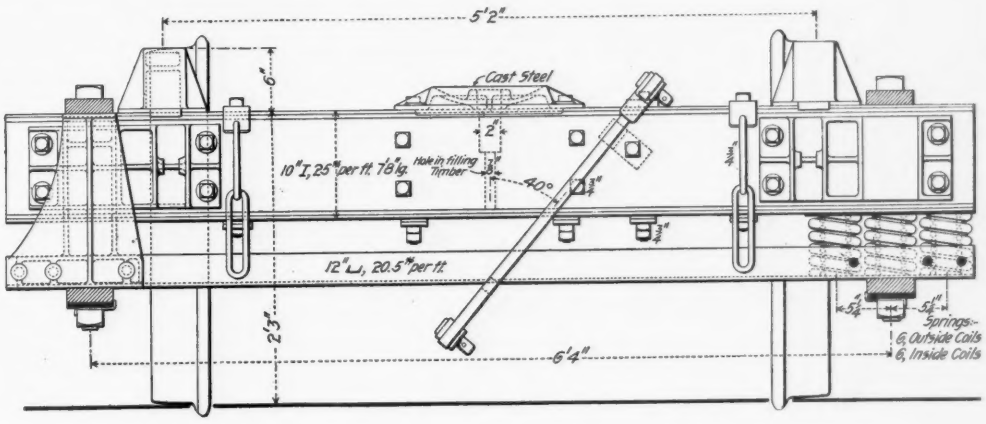


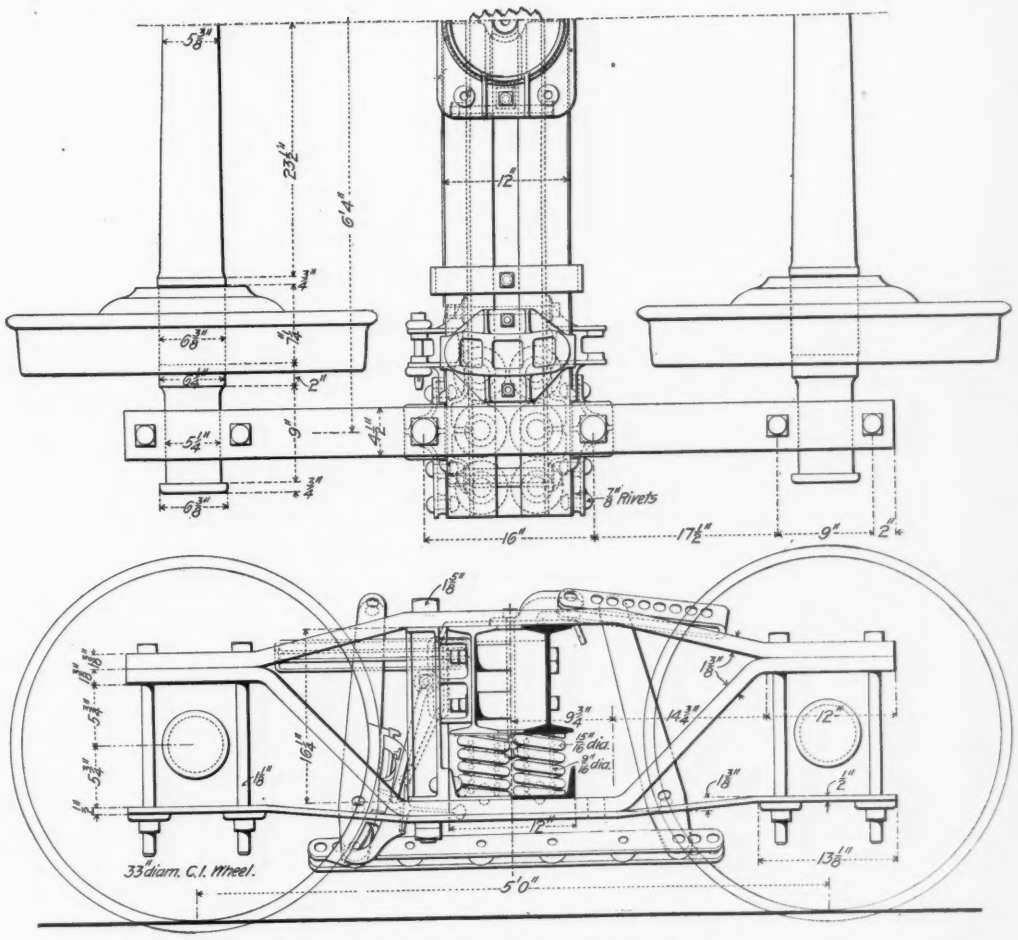
Body Bolster and Cross Section.

shops. The use of power cranes of large capacity, electric motors, gas engines and air compressors has changed the condition of things so that the arrangement of modern shops will be quite different from the old style.

Most of the large railroad systems are still using the repair shops which were built a generation ago. In many cases they have been enlarged by adding on to one end, but the original plan and system of working remains the same. This consists essentially of a building with cross tracks, leading to a transfer table, by which locomotives or cars are delivered to any track in the building. With the advent of heavy-power cranes for lifting locomotives, the longitudinal plan of erecting shops was introduced, and we have examples of it in the shops at Altoona, Roanoke, Burlington, and Concord. Recent shops on the cross-track plan are those at Depew, Oelwein, Reading and Burnside. The older shops on the cross-track plan are not provided with power cranes, and the walls are too low and too weak for their introduction. They are arranged with the erecting shop, surrounded with other buildings, so that sufficient unoccupied space for a new erecting shop cannot be conveniently located with respect to the machine shop.

In plans for the enlargement of such a shop a better





New Norfolk & Western Truck, 80,000 lbs. Capacity.

arrangement can be worked out than that usually adopted of simply extending the old erecting shop with its low walls. We suggest the use of the space occupied by the transfer pit for a new erecting shop, leaving the old erecting space for new tools and air brake or rod shop. The space between the new erecting shop and old buildings adjacent could be roofed with a large proportion of glass, and by this means a very large additional floor space is added to the shop and no new side walls are required for the new erecting shop. Possible objections relating to light and air can be easily met by skylights and louvre sash.

If it is desired to arrange the new shop on the longitudinal plan the tracks for locomotives under repair will be at right angles to those in the old shop and to the main track leading to the old transfer table. For this reason it will be necessary to have a turntable at one end of the new shop. If the cross plan is adopted the new shop can extend so that the last pit coincides with the main track approach to the transfer table.

There appears to be no settled opinion as to which plan, the cross-track or the longitudinal plan for erecting a shop is the best. Each has its strong supporters, sustained by actual examples in modern shops, about as many of one kind as the other. The arguments in favor of the longitudinal plan have been frequently stated, but may be summed up as follows:

1. No transfer table required.
2. No space occupied by transfer pit.
3. No time lost in men and material crossing transfer pit.
4. Numerous large doors avoided. (These are difficult to keep tight and the shop is more difficult to heat.)
5. The usefulness of crane capacity is doubled, as two lighter cranes are employed in light lifting instead of one large one.
6. For a large number of engines the shop need not be so long.
7. Last, but not least, a shop with engines placed lengthwise, with most workmen on the sides, can be more easily supervised by foremen than a transverse plan, where the men on one engine only are in view at a time.

It is not necessary, as is often stated, to lift engines over others in order to place them in a longitudinal shop, as they can be carried along between the side and the center tracks.

There is a tendency in industrial establishments generally to build long lines of shops, few in number and of uniform width, so that one design and span for roof truss will answer for all, instead of numerous detached buildings of various widths. It is found that a number of departments can be conveniently connected in one building with light partitions, instead of detached short structures, each requiring expensive end walls, and in bad weather intercommunication is at a disadvantage. The Horwich shops of the Lancashire & Yorkshire Railway are a remarkable example of this practice. Here we find the standard width for large shops is 111 ft., and there are as many as 4,433 lin. ft. of shops of this width. This is equivalent to 22 shops 200 ft. long, or 11 shops 400 ft. long. The longest single shop of this width is the erecting shop, which is 1,500 ft. long. Another building, 1,435 ft. long, of the same width, contains the boiler shop, the smith shop, the forge, the steel foundry and the iron foundry; all of these departments being of that kind where iron and steel are worked in a heated or molten state requiring forges, furnaces, cupolas, etc.

In this country we have several examples of the erecting shop and boiler shop combined in one building, as at Roanoke and Concord. At Oelwein there is the unusual combination of erecting shop, boiler shop and coach shop in one building on one side of the transfer table, and the freight car shop and the paint shop, with the smith shop between them, in one continuous building on the opposite side of the transfer table. Thus all the principal departments, excepting planing mill, of both car and locomotive departments, are concentrated in two long buildings, each facing the transfer pit. There is no doubt that a given amount of floor space can be more cheaply housed in this manner, where numerous gable ends are avoided and the saving in expense in handling material and time of workmen, where departments are thus concentrated, must be considerable, as compared with the working of shops on the detached plan.

The old plan of having the car department entirely separate from the locomotive department, each with its own machine and smith shops, is not reproduced in the new arrangements. This is partly due to the fact that the control of both departments is now assumed by the superintendent of motive power. The concentration of shop departments in this way immediately results in a saving of two complete buildings, with their separate equipment of tools and a reduction in the number of foremen, clerks and other force required for supervision. Of course, the tools, forges, etc., required by the car department will have to be provided in the general smith shop and machine shop, but the number of them need not be so large as would be required by two separate buildings, and the tools which are installed will be more likely to be fully occupied a greater portion of the time. Repair shops for both car and locomotive departments for a road of average size may thus be arranged in four main buildings instead of eight, as required by the old style with separate departments. The few large buildings can be more easily and cheaply heated, and, as before stated, the cost of construction and operation is much less.

With electric motors it is easily possible to locate a few tools like drill presses, lathes and bolt threaders at a point convenient to car or truck erecting shop, but for new construction the bulk of the machine and forge work should be done in the main shops.

There is now a large number of steel cars in service, and many additional ones are built every year. Provision for the repairs to this class of cars must be made in any new car shop for a large system. As the work is all in metal, it would naturally require the tools found in a boiler and tank shop, or the smith shop. It is a question whether provision for repairs to steel cars should be made in or near the boiler and tank shop or whether a special shop should be specially arranged for the purpose. It is claimed that the life of steel cars will be nearly 30 years, and that the cost of repairs per year will be very slight. It is, therefore, probable that for several years to come repairs to steel cars will not demand a special shop, and the experience gained in these years will indicate the character of the shop best suited for the purpose.

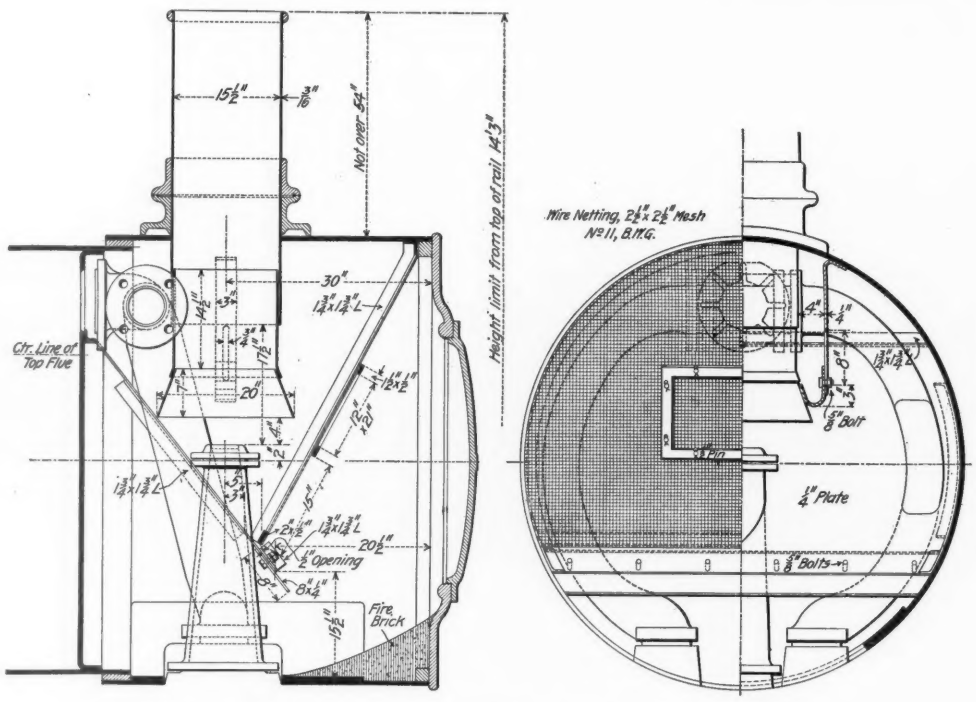
In the modern powerhouse for railroad shops we have another illustration of the tendency toward concentration. Here we may find in one building the boilers, steam or gas engines, electric generators, air compressors and hydraulic pumps.

With the progress now being made in gas engines and gas producers it may be possible to transmit power to the main shops of a railroad plant by gas mains to points where large amounts of power are required, and gas engines could also be used for the electric generators and air compressors in the power-house. In such a case the only boiler requirements would be for heating, and the boilers could be entirely dispensed with during the summer months.

W. F.

The Turner Locomotive Front End.

The recommendations of the Master Mechanics' Association, on the subject of locomotive front ends, at the conventions of 1894 and 1896, are generally understood and have been extensively concurred in, and the most prominent examples of approved recent practice are all in the line of indorsing the sixth conclusion of the 1894 report, which will bear repetition without risk of contradiction. viz.: "This test shows that an increase of the length of the smoke box, over and above that necessary to get in a cinder pocket in front of the cylinder saddle, is unnecessary and undesirable, as the long smoke box greatly decreases the vacuum. Sufficient area of netting can be put into a smoke box which is long enough to give room for a cinder pocket in front of the cylinder saddle."



The Turner Locomotive Front End.

There are not a few who believe that the cinder pocket is as useless as the long smoke box, and that the limit of smoke box length should be that which will allow a sufficient area of netting to be provided. Singularly enough, there are others who continue to use the extended smoke box, but do not use the cinder pocket. Just why this is done is not apparent to the ordinary mechanical mind. If the engine does not clear itself of cinders some means of removing the accumulation from the smoke box would seem to be necessary; while if it does clear itself, an extended smoke box has no possible reason for existence.

The tendency to standardize a short front and open stack, the theoretical soundness of which is unquestionable, is so general that this construction may now be safely accepted as the proper one. Recent tests on the Union Pacific and Colorado & Southern roads are understood to have been so satisfactory and conclusive as to cause the displacement of the diamond stack, which was formerly used on the roads referred to, and to bring about the substitution of the front end designed by Mr. J. S. Turner, Superintendent of Motive Power of the Fitchburg R. R., which design dispenses with both the extended smoke box and the cinder pot. The leading features of this construction will be seen from the illustrations to be a short smoke box (30 in. from the center of the exhaust to the front), an open stack, a deflecting plate extending from a short distance in front of the exhaust pot, and a single inclined sheet of netting, running from the lower end of the deflecting plate to the top of the smoke box. An inward extension of the stack, to a point slightly above the exhaust nozzle, is provided, being the equivalent of a petticoat pipe, which could be equally well adopted.

In the particulars of simplicity and small cost of application, the Turner front would seem to be at least equal, if not superior, to any that has yet been prescribed, and no reason appears why its performance should not be entirely satisfactory, as is claimed to be the case in the instances in which it has been applied. The form shown is that used in passenger engines recently built for the Fitchburg R. R. by the Schenectady Locomotive Works, these engines having 19 x 26-in. cylinders and 72-in. driving wheels, with boilers of 2,200 sq. ft. of heating surface and 31 sq. ft. of grate area. These engines have given excellent results as to steaming and fuel economy, and with a fair grade of bituminous coal, are found to steam very freely with a 5-in. exhaust nozzle, which is materially above the average performance of engines of that diameter of cylinder. It is probable that still better results would be attained if a taper stack, of about 14 in. diameter of choke were used.

As this front is not understood to be patented, its adoption might be considered with advantage by those who are struggling with the difficulties of extended smoke boxes and the cramped exhaust nozzles and cinder pots which are usually found in company with them.

J. Snowden Bell.

Locomotive Rating on the Mexican Central.

Since 1884, with such modifications from time to time as experience has demonstrated to be desirable, it has been the custom on the Mexican Central Railway to prepare books of locomotive rating; that is, the load which the engines will haul over the line, and to furnish them to the employees of the operating department, such as yardmasters, whose duty it is to make up the trains. The object is to give to each class of engines the load that it can readily haul under normal conditions. By so doing, the overloading of engines is avoided and at the same time the maximum amount of freight is moved.

The accuracy of the tables in these books has been from time to time verified by actual experiments with loaded trains, every car of which was weighed, the trains run for several hundred miles without breaking bulk, and a dynamometer car used to determine the resistance. The present system of rating gives satisfaction not only to the officers of the road, but also to the employees. Enginemen and conductors, knowing what tonnage the engines can haul, usually ascertain before taking out a train whether they have the proper amount, and after finding out that the engine is not overloaded, know that they have got to get over the division. In case an engineman has difficulty with his train, and thinks that he has been given too much load, he wires ahead to the end of his run, and on its arrival the train is run over the scales. If the load is all right, he is asked for an explanation, but if it is too much, the responsibility rests on the yardmaster, and he is called upon.

In making up these books, a sample sheet of which is given below, the following formula, tables, and diagrams, are used to simplify the work. The engines are divided into classes, designated by the letters of the alphabet, and

each has its class painted on the side of the cab. All engines in the same class have equal tractive power.

To calculate the tractive power the formula

$$T = \frac{d^2 \times S \times .70\ P}{D},$$ is used, in which

T = tractive power in pounds
d = diameter of cylinder in inches
S = length of stroke in inches
P = boiler pressure in pounds per sq. in.
D = diameter of drivers in inches.

It will be noted that 70 per cent. of the boiler pressure is used, as it is desired to obtain the tractive power when the engine is running about 15 miles per hour instead of the tractive power at starting; and it has been determined by taking indicator cards that only about 70 per cent. of the boiler pressure is available as mean effective pressure in the cylinders when running at that speed. This tractive power should represent about 20 per cent. of the weight on drivers.

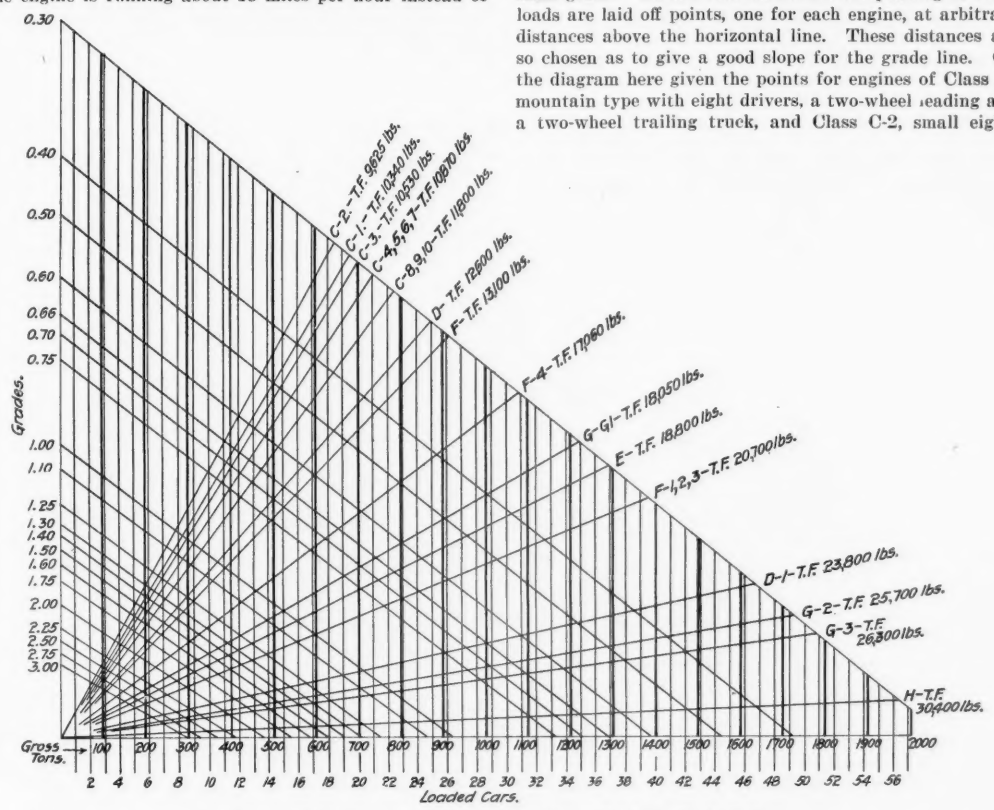


Fig. 1.—Diagram of Locomotive Rating—Mexican Central Ry.

It will be noted that 70 per cent. of the boiler pressure is used, as it is desired to obtain the tractive power when the engine is running about 15 miles per hour instead of the tractive power at starting; and it has been determined by taking indicator cards that only about 70 per cent. of the boiler pressure is available as mean effective pressure in the cylinders when running at that speed. This tractive power should represent about 20 per cent. of the weight on drivers.

To get the train resistance, the rolling friction on straight and level track at low speeds is taken as 6 lbs. per ton of 2,000 lbs. To this must be added the resistance due to velocity and resistance due to grades. The former is calculated from the formula $R = \frac{V^2}{172}$, in which, R = resistance, and V = velocity in miles per hour; and the latter from $R = \frac{f \times 2000}{5280}$, in which f = rise in feet per mile. This formula reduced to a more convenient form is R = .379f. From these formulae the following table is calculated:

Total Resistance, Per Gross Ton of 2,000 lbs., of Trains Running 15 Miles Per Hour Over Various Grades; Curves Compensated.

0.0	per cent.	=	7.31 lbs.	1.6	per cent.	=	39.33 lbs.
0.1	"	=	9.31 "	1.7	"	=	41.33 "
0.2	"	=	11.31 "	1.8	"	=	43.33 "
0.3	"	=	13.31 "	1.9	"	=	45.33 "
0.4	"	=	15.31 "	2.0	"	=	47.33 "
0.5	"	=	17.32 "	2.1	"	=	49.33 "
0.6	"	=	19.32 "	2.2	"	=	51.33 "
0.7	"	=	21.32 "	2.3	"	=	53.34 "
0.8	"	=	23.32 "	2.4	"	=	55.34 "
0.9	"	=	25.32 "	2.5	"	=	57.34 "
1.0	"	=	27.32 "	2.6	"	=	59.34 "
1.1	"	=	29.32 "	2.7	"	=	61.34 "
1.2	"	=	31.32 "	2.8	"	=	63.34 "
1.3	"	=	33.32 "	2.9	"	=	65.34 "
1.4	"	=	35.33 "	3.0	"	=	67.34 "
1.5	"	=	37.33 "				

This table of resistance, together with the tractive powers of the different classes of engines is used in preparing the diagram shown in Fig. 1, from which the total load hauled by the engines is taken, and also the number of loaded cars in which the load can be hauled. The diagram is prepared in the following manner: Upon the horizontal line at the bottom of the diagram are laid off at any convenient scale the gross tons of load which in this case are metric tons of 2,200 lbs. = 1,000 kilograms, the metric system being used in Mexico. Vertical lines are drawn at these divisions. The average weight of a loaded car is taken at 35,000 kilograms = 35 tons, and the horizontal line is further subdivided for loaded cars as is shown. The tractive power of the engines divided by the resistance in pounds per ton gives the total load, inclusive of engine and tender, which the engine will haul at 15 miles per hour over the various grades. From this total load is subtracted the weight in tons of engine and tender, and the result is the load behind the tender, or the train. Now the load which the engine with the greatest tractive power will haul on the least grade here considered (0.3 per cent.) is calculated, as is also the load which the engine with the least tractive power will haul on the same grade. On the vertical lines corresponding to these loads are laid off points, one for each engine, at arbitrary distances above the horizontal line. These distances are so chosen as to give a good slope for the grade line. On the diagram here given the points for engines of Class H, mountain type with eight drivers, a two-wheel leading and a two-wheel trailing truck, and Class C-2, small eight-wheel, are taken. The line connecting these two points is called the grade line for 0.3 per cent. grade. The train loads for the engines intermediate between these two are calculated, and the intersections of the vertical lines corresponding to the train loads with this grade line are marked. These points are connected by lines to the origin in the lower left hand corner of the diagram. The lines thus obtained are called lines of tractive power, and their inclination is in the opposite direction to that of the grade lines. In a similar manner the remaining grade lines are laid down and the diagram is complete. It is now a simple matter to pick out the load in tons and the number of loaded cars which an engine will haul on any of the grades given, and, if necessary, additional grade lines can be put in. This diagram would in fact serve the purpose as far as loaded cars are concerned, but to make it simpler for the men, and in order to prevent mistakes, and to show the rating when all the cars are not loaded, the rate sheets have been prepared.

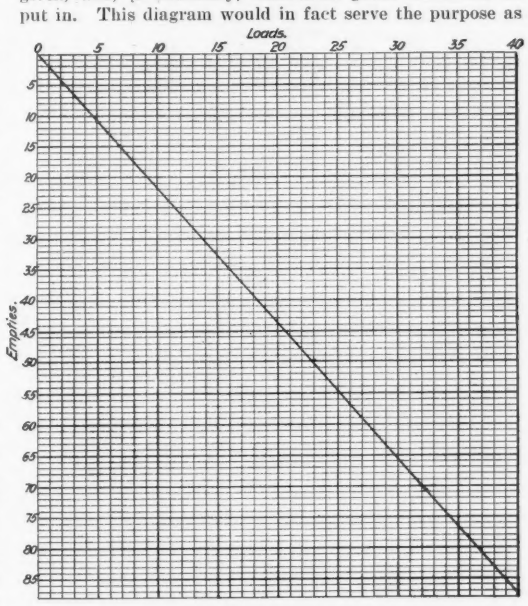


Fig. 2.—Diagram Showing Loaded Cars and Their Equivalent in Empties in Making Up Trains—Mexican Central Ry.

ENGINES, CLASS G—2. 21x26-inch Cylinders, 57-inch Drivers.

Tampico to Tamasopo. Ruling Grade, 1.40.		Tamasopo to Cardenas. Ruling Grade, 3.00.		Cardenas to San Lazaro. Ruling Grade, 1.30.		San Lazaro to Villar. Ruling Grade, 3.00.		Villar to San Luis. Ruling Grade, 1.50		San Luis to Salinas. Ruling Grade, 1.50.		Salinas to Garcia. Ruling Grade, 1.00		Garcia to Aguascalientes. Ruling Grade, 0.30	
Cars.	Kilos.	Cars.	Kilos.	Cars.	Kilos.	Cars.	Kilos.	Cars.	Kilos.	Cars.	Kilos.	Cars.	Kilos.	Cars.	Kilos.
16	545.000	7	235.000	16	570.000	7	235.000	14	510.000	14	510.000	22	755.000	..	.....
17	538.000	8	228.000	17	563.000	8	228.000	15	503.000	15	503.000	23	748.000	..	.....
18	531.000	9	221.000	18	556.000	9	221.000	16	496.000	16	496.000	24	741.000	..	.....

Fig. 3.—Sample Page of Engine Rating Book, Mexican Central Ry.

Finally, in making up the book of rating, a sample page of which is here shown as Fig. 3, each class of engines occupies two pages, one for north-bound trains and one for south-bound. From diagram, Fig. 1, the weight of train and the minimum number of cars is taken. From diagram, Fig. 2, is taken the number of empties equivalent to these loaded cars. The weight of the train is then diminished 7,000 kilograms for each additional car. At first sight it may be thought that this reduction of 7 tons for each car added is too much, being more than the theoretical reduction, but it is considered good practice on this road, and is the result of long observation and experience.

The sample page here given is for Class G-2, consolidation type engines, weighing 185,000 lbs., of which 160,000 lbs. is on drivers. The ruling grade between Tamasopo and Cardenas is 3.0 per cent., and is about 19 miles long. On this grade two engines are usually used, one a pusher, and in this case a reduction of 10 per cent from the combined ratings of the engines is made. When double-headers are used no reduction is made.

Stationary Shop Boilers.

BY F. W. DEAN.

The consideration of the best type of boilers for railroad shops by the American Railway Master Mechanics' Association this year has brought the question of the merits of different kinds of boilers before the railroad public.

There is a great tendency nowadays among people in general, thoughtlessly, I think, and by those who are not versed in fundamental principles, to accept it as a fact that water tube boilers have various merits over fire tube boilers. They seek to prove this by stating certain arguments which are constantly reiterated by the sales agents of water tube boilers, scarcely a single one of which is true. This is all the more regrettable because it leads to an expenditure for boiler plants which is almost double that for the common horizontal tubular boiler, which is far better from nearly every standpoint. This is done with various objects in view, scarcely one of which is ever realized, and I consider that it will be a misfortune for the railroads if they are influenced in any way to install water tube boilers in the future.

I should make a special plea for the locomotive type of boiler for railroad shops on the score of economy of fuel, if it were not for the cost of such boilers, but I shall below give proof of their great economy in stationary service, and in a few instances on locomotives. In fact, the evidence is that they are the most economical type in existence. The prevailing idea that they are wasteful must come from their performance upon locomotives, the cause of which is not due to the boilers themselves, but to the tremendous rate at which they are worked, and want of information of their performance for stationary service. I believe that any of the locomotive boilers that have been built within the last 10 years, if worked at such a rate that they would burn from 30 to 60 lbs. of coal per square foot of grate per hour, would give a higher evaporation than any stationary water tube boiler. Compare the evidence of tests Nos. 19 and 21 with those in the list of water tube tests, herewith given. In other words, if they were so worked that the exhaust would allow the coal to be burned instead of being thrown bodily into the atmosphere through the stack, this result would follow. The gentle action of the exhaust would not only act favorably, but the comparatively infrequent opening of the fire door when burning the amount of coal stated would be conducive to economy. There are several reasons why this is so, as follows:

1. Gas analyses show that rapid combustion* is as good as, and even better than, slow combustion.

2. With rapid combustion* the various losses are smaller in proportion to the heat generated than with slow combustion.

3. With rapid combustion* tubes are kept cleaner than with slow combustion, because the rapid flow of gases sweeps the tubes clean.

Statements have been made which are equivalent to the following, which I shall comment upon as I give them:

Locomotive Boilers.

1. A certain shop has some locomotive boilers for the use of which no favorable argument can be made.

I have found the economy of locomotive boilers greater than that of any other kind, and as evidence of this refer to the preceding data, the tests being made by myself except as noted, and nearly all by the standard fresh wood fire method of the American Society of Mechanical Engineers, the others with a running start and stop.

Possibilities of Improvement.

2. There is an awakening to the possibilities of improvement over such practice.

*It is to be understood that the word rapid as here used means rapid for stationary work.

From the results of the tests that I have given the awakening should be to a realization of the excellence of locomotive and horizontal tubular boilers, and I should add, to the vertical fire tube boilers, which give results a good second to locomotive boilers.

Repairs to Boilers.

3. Certain plants of water tube boilers have been in use for 10 years without repairs.

The statement that certain plants of water tube boilers have been in use for 10 years without repairs is indefinite, for no doubt there are many of horizontal tubular and other fire tube boilers of which the same can be said. I know of a plant of 11 78-in. horizontal tubular boilers, eight of which have been in use 14 years without repairs, and three for 9 or 10 years without repairs, all carrying 135 lbs. of steam now and from the beginning. I knew of some that had been in for 24 years with the original set of tubes, and I believe without repairs.

Many kinds, if not of all, of water tube boilers require the tubes to be bored out so often, even in moderately poor water, with which horizontal tubular boilers are not disadvantageously affected, that they should have the expense of this charged to repairs.

The behavior of water tube boilers in bad water is something extremely serious from an economical standpoint, for even large tubes fill or become thickly coated with incrustation in a comparatively short time. It is even admitted by some makers that their boilers would be useless if they had not been able to devise a machine for boring bent tubes, for the tubes would not only be lined with deposit. but would be solid full, and have often been found so. A lining of deposit nearly an inch thick is common even with moderately poor water, such as would make no deposit on fire tubes, in a comparatively short time, and with such a condition what a serious falling off in economical evaporation there must be. The writer knows of cases of this kind.

Forcing Capabilities.

4. Water tube boilers can usually be forced far beyond their rated capacity, but with this exception, it is possible

LOCOMOTIVE TYPE BOILER (ALL HAND-FIRED)

Number.	Year.	Location.	Grate Area, Sq. Ft.	Heating Surface, Sq. Ft.	Steam Pressure, Lbs.	Boiler H. P. Developed.	Kind of Coal.	Coal Burnt per Sq. Ft. of Grate per Hour, Lbs.	Water Evaporated per Hour per Sq. Ft. Heating Surface from and at 212°, Lbs.	Evaporation from and at 212°. Per Lb. Coal, Lbs.	Evaporation from and at 212°. Per Lb. Combustible, Lbs.	Boiler H. P., per Sq. Ft. of Grate.	No. Sq. Ft. of Heating Surface per H. P.	Temperature Escaping Gases, Degrees Fahrenheit.	Tested by
1	1893	New Bedford W. W.	30.5	1,883	114	94.55	Cumberland	8.85	1.49	12.08	12.88	3.10	19.92	360	Dean.
2	"	"	30.5	1,883	113	173.84	"	16.06	2.72	12.23	12.90	5.70	10.83	469	"
3	"	"	45	1,883	113	92.75	Pocahontas	6.31	1.70	11.29	12.10	2.06	20.30	384	"
4	"	"	45	1,883	113	176.66	"	12.18	3.24	11.12	11.93	3.93	10.65	538	"
5	1892	Newton Water Works	48.12	2,310	126	114.20	Cumberland	7.23	1.51	11.32	12.24	2.37	20.20	440	"
6	1894	Taunton Loco. Co.	27.25	1,412	95	70.7	"	8.22	1.73	10.89	11.83	2.60	19.97	401	"
7	1897	Boston W. W.	20.62	937	78	38	"	5.95	1.40	10.71	12.09		24.70		"
8	1885	" Sewage Works	45.5	1,826		112	"	7.35		11.60	12.23				Brackett.
9	"	" " "	45.5	1,826		129	"	8.62		11.35	11.98			439	"
10	1892	Mason Mch. Works	30.3	976	85		"	4.66	1.52	10.53	11.66			365	Dean.
11	1898	Lynn Water Works	29	1,500	89	136	"	14.00	3.13	11.53	12.84	4.69	11.03	420	"
12	"	" " "	29	1,500	89	150	"	16.00	3.44	11.08	12.04	5.17	10.00	478	"
13	1897	Washington Mills*	60	5,300	122	623	Pocahontas	31.66	4.05	11.32	12.47	10.38	8.51	526	"
14	"	" "	"	"	123	581	N. River	28.10	3.78	11.87	12.96	9.69	9.12	516	"
15	"	" "	"	"	123	557	"	28.50	3.63	11.25	12.33	9.29	9.50	496	"
16	"	" "	"	"	123	572	Pocahontas	29.30	3.72	11.24	12.48	9.54	9.26	511	"
17	1898	" "	"	"	119	416	N. River	21.30	2.71	11.22	12.31	6.94	12.72	472	"
18	"	" "	"	"	123	426	Pocahontas	20.90	2.71	11.73	12.93	7.10	12.42	482	"
19	1891	O. C. Comp. on Fast Freight	19	1,400	174 av.		Pocahontas and Cumb.	58 to 68		9.68 to 10.74	10.58 to 11.93				"
20	1892	Oxford, Eng., El. Lt. Sta.								11.75					Unwin (?).
21	1887	Three tests, Gt. Eastern Ry., England	12.4	859	av. 124		Nixon's Navigation	28.1 to 35.5	5.10 to 6.25	12.18 to 12.51	13.00 to 13.30			570 to 617	Donkin & Kennedy
22	"	Rankin's Factory, London	9.68	316	61		"	12.4	4.05	10.78	11.25			625	"
23	1889	Brussels, Belgium	31.43	1,177	90		"	25.5	7.23	10.64	11.42				"
24	1879	Lawrence W. W.	28.75	1,020	90		Cumberland	8.38	2.71	11.49	12.24				R. H. Buel.
Average evaporation, using one test from each boiler										11.18	12.05				

* These boilers have corrugated furnaces instead of staybolt furnaces.

HORIZONTAL TUBULAR BOILERS.

Number.	Year.	Location.	Grate Area, Sq. Ft.	Heating Surface, Sq. Ft.	Steam Pressure, Lbs.	Boiler H. P. Developed.	Kind of Coal.	Coal Burnt per Sq. Ft. of Grate per Hour, Lbs.	Water Evaporated per Hour per Sq. Ft. Heating Surface from and at 212°, Lbs.	Evaporation from and at 212°. Per Lb. Coal, Lbs.	Evaporation from and at 212°. Per Lb. Combustible, Lbs.	Boiler H. P., per Sq. Ft. of Grate.	No. Sq. Ft. of Heating Surface per H. P.	Temperature Escaping Gases, Degrees Fahrenheit.	Tested by	How Fired.
25	1890	Washington Mills	56	2,240	133	...	Cumberland	9.52	2.09	10.62	11.21	...	...	428	Leavitt	Hand
26	1894	Boston W. W.	36.75	2,164	67	167	Pocahontas	13.42	2.66	11.42	12.23	4.54	12.96	389	Dean	"
27	"	Atlantic Mills	21.77	1,112	84	139	Cumberland	21.4	4.30	10.46	11.18	6.37	8.00	373	"	"
28	"	" "	21.51	1,112	85	145	"	21.7	4.49	10.71	11.57	6.73	7.70	389	"	"
29	1895	Laurel Lake Mills	36	1,787	107	91	Clinch Valley	8.25	1.75	10.52	11.84	2.52	19.71	350	"	"
30	1900	Cumberland Mills	48.75	4,027	92	630	Cumberland	42.2	5.39	10.57	11.53	12.92	6.39	569	"	"
31	"	" "	61.87	4,027	94	742	"	37.6	6.35	11.53	12.06	12.00	5.43	645	"	Chain grate stoker
32	"	" "	48.75	4,027	96	353	"	22.5	3.02	11.11	12.84	7.42	11.41	473	"	Hand
33	"	" "	61.87	4,027	95	383	"	21.3	3.28	11.41	13.27	6.19	10.53	492	"	Chain grate stoker
34	1896	Globe Yarn Mills	25.00	1,400	115	132	Pocahontas	17.8	3.27	10.28	11.02	5.28	10.60	388	"	Hand
35	1894	Lowell W. W.	36.00	1,755	148	106	Cumberland	10.11	2.09	10.08	11.00	2.95	16.56	372	"	"
36	Unknown	3-boilers	90.00	3,374	84	204	"	7.00	1.80+	11.33	12.07	...	...	431	Barrus	"
37	"	2- "	49.3	2,100	65	178	"	11.10	2.60+	11.20	11.98	...	...	408	"	"
Average evaporation, using one hand fired test from each boiler										10.76	11.66					

CORLISS AND MANNING VERTICAL WATER LEG (ALL HAND-FIRED).

Number.	Year.	Location.	Grate Area, Sq. Ft.	Heating Surface, Sq. Ft.	Steam Pressure, Lbs.	Boiler H. P. Developed.	Kind of Coal.	Coal Burnt per Sq. Ft. of Grate per Hour, Lbs.	Water Evaporated per Hour per Sq. Ft. Heating Surface from and at 212°, Lbs.	Evaporation from and at 212°. Per Lb. Coal, Lbs.	Evaporation from and at 212°. Per Lb. Combustible, Lbs.	Boiler H. P., per Sq. Ft. of Grate.	No. Sq. Ft. of Heating Surface per H. P.	Temperature Escaping Gases, Degrees Fahrenheit.	Tested by
38	Unknown	..	28.3	1,200 & 1,700 total	46	243	Cumberland	13.1	3.2+*	11.34	12.29	...	...	427	Barrus.
39	1897	Grosvenordale Mills	33.2	1,480 & 2,154	153	123	"	11.7	2.86*	10.94	11.96	3.72	12. *	520	"
40	1894	Whitman Mills	28.27	1,388 & 1,869	123	194	Pocahontas	23.0	4.90*	10.07	12.00	6.85	7. *	531	Denton.
41	"	" "	"	"	123	126	"	14.7	3.10*	10.38	12.32	4.47	11. *	496	"
42	"	" "	"	"	156	95	"	10.9	2.30*	10.62	12.35	3.38	15. *	362	"
43	"	Manchester W. W.	28.27	"	142	98	Cumberland	11.0	2.44*	10.89	11.92	3.47	14. *	380+	Dean.
44	"	" "	"	"	140	103	"	12.64	2.56*	9.92	11.11	3.64	13.3 *	397+	"
45	"	Lawrence Mfg. Co.	23.80	1,090 & 1,454	158	98.5	"	14.00	3.12*	10.21	11.17	4.14	11.0 *	434	"
46	"	" "	"	"	96	93.5	"	12.90	2.96*	10.32	11.47	3.93	11.6 *	380	"
47	"	Narragansett Mills	33.4	1,384 & 2,036	114	119	Pocahontas	11.30	2.90*	11.19	11.92	3.57	11.6 *	395	"
48	"	" "	"	1,492 & 2,036	115	162	"	15.20	3.69*	11.02	11.83	4.85	9.2 *	439	"
49	"	" "	"	"	116	205	"	20.00	4.66*	10.60	11.27	6.14	7.28*	501	"
50	"	" "	"	"	114	214	"	21.17	4.83*	10.43	11.27	6.41	6.97*	555	"
51	"	Kumhardt's Mill	28.2	1,745 total	67	115	Cumberland	12.70	2.28†	10.96	11.64	4.09	15.10†	491	"
52	"	" "	28.2	"	69	102	"	11.50	2.02†	10.82	11.48	3.62	17.1 †	519	"
53	1895	Berkeley Mill	33.4	1,384 & 2,037	129	103	Pocahontas	10.37	2.57*	10.25	11.12	3.09	13.4 *	437	"
54	"	Fletcher Mfg. Co.	33.4	1,897 & 2,431	79	226	"	21.56	4.11*	10.83	11.50	6.77	8.4 *	422	"
55	"	" "	"	"	79	177	Cumberland	17.63	3.21*	10.35	11.11	5.30	10.7 *	414	"
Average evaporation, using one test from each boiler										10.65	11.65				

*Excluding superheating surface. †Including superheating surface.

to select a water tube boiler that is inferior to the common horizontal tubular boiler.

In regard to forcing, the statement that water tube boilers can *usually* be forced beyond their rated capacity merely implies that the fire tube boilers can not be. A moment's consideration must show that the ability to force a boiler depends upon the ability to increase the draft beyond that usually obtained, and as nearly every plant has and should have a surplus draft, the mere opening of a damper is all that is necessary to produce the forcing. There are cases where boilers are equipped with grates so fine that they soon stop up with ashes and clinkers, and in these cases an increase in draft can accomplish but little. In such cases the boiler gets a bad reputation for want of capacity when it is due solely to the grate. I have replaced recently an overgrown plant of tubular boilers that had narrow openings in neglected old warped grates that were always filled full of cinders and ashes so that they could do nothing, by a few water tube boilers having an excellent open shaking grate. The old boilers also had a great ramification of smoke flues so arranged that the chimney draft was materially reduced before it reached the obstructed grates, and the total effect was that what was a surplus amount of grate area and heating surface was frequently insufficient to make the steam required. The lesser amounts of each in the new boilers with their efficient grates and ample and direct flues are proving to be a surplus. This might be by many, and perhaps is, wholly attributed to the qualities of water tube boilers.

Let us look into the *rationale* of this matter. A boiler that has its heating suface so disposed that it is all useful ought to be the best boiler for forcing. With an open grate and plenty of draft there is no practical limit to forcing, and the more the fire is driven the more steam the boiler will make. Often the economy falls off, but that is not necessarily so. In every water tube boiler there is considerable heating surface that is never effective, because, partly, the gases never can go into the corners, and because also some of the surface is covered with tiles. It is claimed by the makers of water tube boilers that have longitudinal paths for gases that the gases fill the corners better than in the case of those boilers having transverse paths for gases, and that thereby they are able to employ only about 8.33 sq. ft. of surface per horse power instead of 10 sq. ft. and still leave ample margin for forcing. There is some truth in this, but the longitudinal layers of tiles on the tubes that produce this effect, cover so much of the tube surface that there is much heating surface practically lost. In any water tube boiler the gases tend to, and do, short circuit and go more or less in straight lines from the edge of one set of tiles to the edge of the next, thus losing the effect of a good deal of heating surface. This can be plainly seen if a person will take the trouble to observe. I have heard it said by an eminent man that a water tube boiler will stand forcing and do in some sense or other better than when running light, because the idle spaces are then better filled with hot gases. This is a very doubtful compliment. In addition to the defects named the tiles of water tube boilers sometimes slip out of place or fall out entirely, and then the gases short circuit more effectively and get to the chimney even more directly than usual. Moreover, the spaces between the tubes average large, and while it is held that the gases passing between two tubes impinge on the next tube above, this is only moderately true; that is to say, some of the gas does and some does not.

Now let us see what is the case with the horizontal return tubular boiler. If the smoke nozzle is as wide as it ought to be, that is to say, if its width almost equals the diameter of the boiler, the distance from the end of the fire to the beginning of the smoke flue is the same through any tube. Therefore, there is no fact of short distance by any path to cause any tube to do less than any other. Moreover, it is inconceivable that the vacuum to produce draft is not the same throughout the smokebox, and therefore, from this condition the effect must be to cause every tube to do its full duty. Still further, these conditions exist whether the boiler is working gently or is being forced. Finally this boiler, for the reasons stated, is ideally a perfect boiler as far as effectiveness of heating surface is concerned. Can any water tube boiler compare with it in the perfection of these conditions? When the gases pass through the tubes the skin friction of the tubes causes the gases to roll over and over again from center to outside, bringing every part of them repeatedly in contact with the tube surface. Nothing can surpass this in effectiveness for causing gases to give up their heat, and in order to adapt them to forcing it is only necessary to lengthen the tubes so that the rolling over process shall be prolonged.

It should be expected, therefore, that they are very efficient boilers when forced. As the most practical evidence of this, I refer to the tests Nos. 30 and 31 in the lists given, which are the results of tests of two of four boilers of the horizontal tubular type 90 in. in diameter, designed by the writer, having 258 3-in. tubes 20 ft. long, and having 4,027 sq. ft. of heating surface on the fire sides for each boiler. It will be observed that 42.2 and 37.6 lbs. of coal were burnt per sq. ft. of grate per hour, respectively, and that a boiler horse power was obtained from 6.39 and 5.43 sq. ft. of heating surface. It will be seen that the temperature of the escaping gases is very low for such tremendous forcing, and that the economy as shown by the evaporative rates has probably never been reached under such conditions by any other boilers. In tests Nos. 32 and 33 the same boilers were run near their rating, which was based on 10 sq. ft. per horse power, and the economic results are extraordinary.

Tests 27 and 28 give results from a horizontal tubular boiler 24 years old having the original set of tubes. They show excellent results when burning coal at a rapid rate and giving a boiler horse power from 8 sq. ft. and 7.7 sq. ft. of fire heating surface respectively.

This time-honored type of boiler only needs a chance to respond to any demand. It is not made in general by men of as much intelligence as those who make water tube boilers, and it is not as aggressively sold. The makers of it do not seem to realize the excellence of the boiler and allow themselves to be out-argued by their water tube rivals. They continue to rate their boilers on 15 sq. ft. of heating surface per horse-power when they can with more propriety reduce it to 10 sq ft. than can the makers of water tube boilers, and they do not put in as many

These tests furnish ample argument to reinstate the fire tube boilers.

Use of Water Tube Boilers in Navies.

5. The use of water tube boilers in navies is quoted as evidence of their value on land.

The recent adoption of water tube boilers in the English Navy is often quoted in their favor, but readers of late numbers of *The Engineer* (London) will plainly see that they are already about to be considered a failure. A great argument in their favor is their lightness over the Scotch marine type, but the chief engineer of the English Navy, Sir John Durston, shows in a paper of his own that this is not borne out, because, as *The Engineer* says, a vessel has to be much over-boilered in consequence of the great number that are out of use for repairs. If I remember rightly, Commodore Melville says that water tube boilers are a necessity for a naval vessel in consequence of their lightness, but that they are wrong in principle. The large English cruiser "Terrible" has had a complete new set of tubes recently, and the "Powerful" is now to have a new set, and both cruisers are nearly new.

Rapid Steaming and Responsive Qualities.

6. Water tube boilers are more rapid steamers than fire tube boilers, and more rapidly respond to sudden demands for steam.

The claim that water tube boilers are more rapid steamers and more readily respond to sudden demands than fire tube boilers is one oftener made than any other. This is asserted on the assumption that they contain less weight of water in proportion to the heating surface than do fire tube boilers. This is a pure and incorrect assumption as can be easily shown. The following figures refer to the three most conspicuous kinds of water tube boilers and others as named of certain sizes that the writer has examined, and gives the weight of water contained in each kind per sq. ft. of heating surface:

Water tube boiler	A..	7.66	lbs.	per	sq.	ft.	of	heating	surface
" " "	B..	8.34	"	"	"	"	"	"	"
" " "	C..	8.62	"	"	"	"	"	"	"
90" hor. tub. boiler		7.74	"	"	"	"	"	"	"
84" " " "		7.24	"	"	"	"	"	"	"
78" " " "		7.00	"	"	"	"	"	"	"
72" " " "		6.73	"	"	"	"	"	"	"
Manning vertical		10.3	"	"	"	"	water	"	"
" "		7.14	"	"	"	"	total	"	"
Corliss "		15.60	"	"	"	"	water	"	"
" "		11.00	"	"	"	"	total	"	"

These figures show that the claim for water tube boilers is one derived from the wish rather than from the fact. One maker of water tube boilers, apparently finding that his boiler contains a great deal of water, makes the best of it and says that it is very advantageous because when the steam pressure falls off the water will liberate steam and tend to keep the steam pressure uniform. The absurdity of this claim is apparent if we consider, for example, that in the case of a boiler holding 16,000 lbs. of water at the temperature of 125 lbs. of steam, that if the pressure should suddenly drop to 120 lbs. only 56 lbs. of new steam would appear at the last named pressure. That would last a 250 horse-power compound engine one minute.

It makes no difference, however, whether a boiler contains much or little water, as far as sensitiveness or responsiveness is concerned, for if a boiler has its working pressure and additional heat is applied on account of the damper opening or the fire being broken up, not a unit of this additional heat can be absorbed by the boiler. The water already has its full supply of "heat of the liquid" and the addition produces evaporation only. If the pressure is down a few pounds the absorption of heat by the liquid while the pressure is reaching its normal is insignificant in comparison with the heat that goes to make steam. If the pressure is undulating the liberation on reduction of pressure counterbalances the absorption on increase of pressure, both being insignificant. The smallness of these quantities can better be realized when it is remembered that one pound of coal in a good boiler will give to the steam 10,000 units of heat and that this will

HORIZONTAL WATER-TUBE BOILERS.

Number.	Year.	Location.	Grate Area, Sq. Ft	Heating Surface, Sq. Ft.	Steam Pressure, Lbs.	Boiler H. P. Developed.	Kind of Coal.	Coal Burnt per Sq. Ft. of Grate per Hour, Lbs.	Water Evaporated per Hour per Sq. Ft. Heating Surface from and at 212°, Lbs.	Evaporation from and at 212°. Per Lb. Coal, Lbs.	Per Lb. Combustible, Lbs.	Boiler H. P. per Sq. Ft. of Grate.	No. Sq. Ft. of Heating Surface per H. P.	Temperature Escaping Gases, Degrees Fahrenheit.	Tested by	How Fired.
56....	1894....	Natick Mills	70.	3,467	150	252	Cumberland	12.57	2.50	9.88	10.51	3.60	13.76	416	Dean	Hand.
57....	"	" "	"	"	140	231	"	11.03	2.29	9.52	10.24	3.30	15.00	388	"	"
58....	1895...	Cumberland Mills ...	59.5	2,649	82	409	Pocahontas	24.34	5.32	9.74	10.53	6.88	6.48	553	"	"
59....	"	" " ...	42.25	"	74	297	"	22.34	3.87	10.86	11.91	7.03	8.91	361	"	Chain grate stoker.
60....	"	" " ...	"	"	76	322	"	25.54	4.19	10.30	11.49	7.58	8.22	372	"	"
61....	"	" " ...	"	"	...	...	Cumberland	23.90	4.36	11.01	12.19	...	...	388	Whitham	"
62....	1897....	Providence Worsted Co.	26.	1,390	89	166	Reynoldsville	26.00	4.12	8.47	9.33	6.38	8.38	473	Dean	Hand.
63....	"	....Providence Worsted Co.	"	"	92	173	"	26.60	4.29	8.61	9.23	6.65	8.05	504	"	"
64...		James Row, Troy, N. Y.	...	...	79	183	Cumberland	14.53	5.38	9.83	...	...	5.77	...	Barrus	"
65...		Warren Mfg. Co.....	...	...	...	132	"	30.70	4.75	10.25	...	...	7.26	...	Evans	"
66....	1886....	Cocheco Mills	...	...	...	...	"	16.32	3.45	10.27	10.98	...	...	428	Barrus	"
67....	1896....	Tremont & Suffolk Mills	...	...	...	...		23.11	4.06	10.94	11.83	...	...	470	Peabody	Chain grate stoker.
68....	Unknown	....	...	...	67	243	Cumberland	16.80	2.30†	9.95	10.79	...	...	452	Barrus	Hand.
69....	"	.. ..	38.9	1,886	...	...		16.30	2.90†	10.28	10.98	...	...	...	"	"
Average evaporation, using one hand fired test from each boiler.....										9.70	10.49					

	Coal.	Combustible.
Saving by use of locomotive type over water tube boiler	13.2%	12.9%
Saving by use of horizontal return tubular over water tube boiler.....	9.8%	10.0%
Saving by use of vertical fire tube boiler over water tube boiler.....	9.0%	10.0%

raise 10,000 lbs. of water 1° F. Finally all boilers with the same amount of heating surface and the same addition of heat are equally responsive, independent of the quantity of water they contain, if they are so designed that they absorb the heat instead of allowing it to pass up chimney.

Use of Water Tube Boilers in Large Electric Stations.

7. The preceding are the reasons why water tube boilers are used in large electric power stations.

In regard to the reasons why water tube boilers are used in the large electric stations, if the responsive qualities and their economy are the causes, they are put in under a misapprehension. The business capacities of the makers and selling agents are more effective in bringing about their use in such places than anything else, and this is more apparent when it is remembered that one kind of water tube boiler is almost exclusively used in these stations, when there are other water tube boilers just as good. Moreover any boiler that has a start in any such place has great advantages for adoption in any other from this fact alone.

Economy of Water and Fire Tube Boilers.

8. In well-designed water tube boilers the evaporation per pound of coal may be expected to be 5 to 10 per cent. greater than in a return tubular boiler. With Pocahontas coal over 11 pounds of water per pound of dry coal, from and at 212°, have been evaporated by a water tube boiler.

In regard to this claim, I have shown that the reverse is true, and that the fire tube boiler shows an evaporation 5 to 10 per cent. greater than the water tube. With Pocahontas, Cumberland and New River coals, there are several cases of not only over 11 pounds evaporation from and at 212° per pound of coal, but even over 12 lbs. with the locomotive type of boiler. So far as I know no such results have ever been obtained with water tube boilers.

The very nature of water tube boilers renders them wasteful, for the fire sides of the tubes can not be cleaned. Blowing in among a lot of tubes that are shielding each other is very ineffective, and the more distant tubes scarcely feel the effect of the blast. Moreover, the steam jet widens out and loses its force a short distance from the outlet. If anybody should be fortunate enough to see a water tube boiler that has been in service a few years, with the brickwork removed, as I have, they would be impressed with the truth of this statement. It is sometimes said that water tubes can be scraped on the outside. It is obvious that they can not be scraped when the boiler is hot, and it surpasses the imagination to understand how a good job can be done under any circumstances. The fact is, moreover, that not one water tube boiler in thousands is every scraped.

Compare these conditions with those of a fire tube boiler. Each tube can be blown with a jet of steam with the absolute certainty that the jet will strike every part of the interior and blow off everything movable, since it is confined and loses none of its force. In addition the tube can be scraped perfectly clean. Moreover both blowing and scraping can all be done while the boiler is in service. A fireman who would not scrape a fire tube once a week would be discharged in most places, but for some reason or other water tube boilers are accepted when they can not be scraped at all and can only be very imperfectly blown. The class of water tube boilers that can be blown through hollow stay bolts parallel to the tubes is somewhat better in this respect, but the steam jet is not confined and is correspondingly ineffective. Besides, the soot and ashes blown from most of the tubes probably lodges on the horizontal layers of tiles and ultimately partially covers the tubes next above rendering them somewhat ineffective.

The accumulating dirt on the outsides of water tubes added to the filling up of the insides renders their efficiency gradually vanishing during their service. These are defects of the greatest importance and I am constantly surprised that they are so little thought of.

Economy in Forcing.

9. In forcing these boilers have given satisfactory economy when burning 35 lbs. of coal per sq. ft. of grate per hour.

I can not contemplate the claim that a satisfactory economy with water tube boilers has been obtained when burning 35 lbs. of coal per sq. ft. of grate per hour without regarding it as very indefinite, and without believing that the showing of the horizontal fire tube boilers in tests Nos. 30 and 31 when burning more than 35 lbs. of coal are *far* more satisfactory. Often the mere fact of being able to keep up steam is the satisfactory part of the experience, with little or no thought of the economy.

As far as forcing is concerned, everybody knows that locomotive boilers on locomotives cause every other case of forcing to be utterly insignificant. The force of the draft is anywhere from 3 to 16 ins. of water.

Circulation.

10. Circulation is important and is defective in locomotive and cylindrical boilers. It has not been given its place in boiler design, and the water tube boiler has been an educator in this direction.

The question of circulation is one that never requires consideration in anything but a water tube boiler. In a fire tube boiler the paths for circulation are short, and the spaces are numerous and effective. My experience, both in stationary and locomotive practice, is that nothing can be done to prevent circulation. I have crowded tubes into a horizontal boiler, placing them ¾ in. apart, but know of no reason to suppose that the water does not circulate properly. The Cumberland Mills 90 in. return tubular boilers with 258 3-in. tubes ¾ in. apart developing a horse power with 5.43 sq. ft. of heating surface give less than ½ of 1 per cent. of moisture in the steam. The Washington Mills 10 ft. boilers with 590 2½-in. tubes ⅞ in. apart, and with no wide mid-space between the tubes, when giving a horse power on 8.51 sq. ft. of heating surface gave ½ of 1 per cent. of moisture. In both of these designs nothing was done to favor circulation and there is no evidence that it is lacking. It might even be said that everything was done to prevent circulation. In making these designs, however, my locomotive experience showed me that there was no risk in carrying out the design as I did. In these cases the circulation demands are insignificant compared with those of the locomotive boiler on wheels.

Safety.

11. Ruptures in water tube boilers are small and therefore not dangerous.

The question of ruptures in the tubes of water tube boilers brings up the question of safety in general, about which the makers of water tube boilers make strong claims. A recent number of the "Locomotive" and of "Power" show the results of an explosion of a vertical water tube boiler which was as disastrous as the explosion of a fire tube boiler could possibly be, six persons being killed and the building demolished. It is therefore apparent that the water tube feature of boilers is not *per se* a source of safety, and it is difficult to see why any water tube boiler that has all, or a collection of, tubes expanded into one drum or one general header should not be as likely to explode as this vertical water tube boiler. The upper drum of this boiler pulled away from the tubes that were expanded into its lower head. Where there are separate headers for a few tubes an explosion caused by one header pulling off would probably not injure property very seriously, but would be sure to kill the persons present. Moreover, the drums of water tube boilers are as likely to explode as the shells of fire tube boilers, from the same causes. They vary in size from say 24 in. to 54 in., 36 in. and 42 in. being very common. The drums are amply large to demolish buildings as well as to kill people. One concern, of which the writer's firm are consulting engineers, recently discovered that a drum plate was cracked all but off and would have certainly exploded in a short time. This drum was made with a lap joint on the longitudinal seam and the bending of the plate at this joint, in order to become more or less circular with variations of pressure caused the crack. I have taken an interest to observe what kind of horizontal tubular or vertical fire tube boilers explode, and find that they are those built with their longitudinal joints lapped, and the ruptures occur at the edges of the joint. I have never known of a horizontal tubular boiler that was built with longitudinal butt joints to explode, and the Hartford Steam Boiler Insurance and Inspection Co., and the Mutual Boiler Insurance Co. inform me that they do not know of a case. It is therefore fair to assume that no fire tube boiler so built has ever exploded, and it is consequently as proper to call a horizontal tubular boiler with butt joints a safety boiler as to so call a water tube boiler. Moreover they are safer than water tube boilers, having their drums built with lap longitudinal joints.

There are some water tube boilers that have four drums. I consider such boilers four times as dangerous as shell boilers because there are four things to explode against one. When these drums have tubes entering one side of the drums and are expanded into a heavier plate riveted to a thin plate by a lap joint, the thin plates are likely to crack at the edge of the lap in time and cause an explosion. Such drums having within them unbalanced pressure, become elliptical with an increase of pressure and vary their form with variations in pressure. The bending effect upon the plates is localized at the edge of the joint and final rupture is probable.

The same action has caused all explosions of horizontal tubular boilers, and I know of several instances where such boilers have cracked clear through at the edges of joints and a hissing steam has called attention to the condition of the boiler before complete rupture has occurred.

It is a matter of regret that the boiler insurance companies have not long since taken a firm stand and refused to insure shell boilers with lapped longitudinal joints, or water tube boilers with such joints in their drums. I hope that they will take this position in the near future.

The point has been made that horizontal tubular boilers have thick joints in the fire and are therefore dangerous, but I have never known this to cause an explosion. Nor has the occasional bagging down of a dirty plate ever caused an explosion as far as I know. This type of boiler ought always to be made with a manhole below the tubes so that the bottom plates can be thoroughly cleaned, and examined.

The explosion of the tubes of water tube boilers is not uncommon, and three cases have recently been brought to my attention. The results were anything but agreeable and far from safe.

Accessibility for Repairs.

12. The parts of water tube boilers are accessible for repairs (and presumably easy to repair).

The claim that the parts of water tube boilers are accessible for repairs implies that the parts of other boilers are not accessible. I can not see how this is more true of water tube than of fire tube boilers. It is certainly not very convenient to remove several hundred handhole plates to clean tubes.

Joints in Fire.

13. Joints are removed from the fire and drums are provided for collecting mud, in the case of water tube boilers.

The mud-drum feature of water tube boilers is good, but it never prevents the tubes from filling up in part, or wholly, and therefore, practically speaking, accomplishes but little. The mud in a horizontal tubular boiler falls to the bottom and should be so frequently removed as to cause no trouble, and in general it causes none. In a locomotive type of boiler if the crown sheet is curved mud does not collect upon it but falls into the water legs where it becomes harmless if frequently removed.

Superheating.

14. Superheating is more easily carried out with water tube boilers than with fire tube boilers, and this is a great advantage of water tube boilers.

I can not see how water tube boilers as a class lend themselves to superheating better than a fire tube. This is certainly not true of all of them.

It seems to me that the merits of superheating are overrated. There is some reason to believe that the number of units of heat per unit of work passing through an engine with superheated steam is as large as with saturated steam. The Schmidt motor is certainly no better than a toy. Superheat in steam is so quickly lost by radiation that it has to be carefully guarded. Where superheat comes from waste products it is desirable, as in a vertical fire tube boiler, where 10 sq. ft. of water heating and some 33 sq. ft. of superheating surface are used per horse power.

Stay Bolts in Locomotive Type Boilers.

The danger of broken stay bolts in this type or in vertical water leg boilers can be entirely overcome by making them hollow.

Stationary Boilers for High Pressure.

It is often asserted that horizontal tubular boilers can not be used for high pressure. They are, however, being built for the Plymouth Cordage Co. and the Calumet & Hecla Mining Co. to carry 185 lbs. When 78 in. in diameter they can be built at least for 165 lbs. and I have recently been informed by a prominent boiler insurance company that they will insure a 90-in. boiler with 11-16 in. plates for 165 lbs. if the plates are planed down to 7-16 in. at the circular joints, the plates of course being of the full thickness at the longitudinal joints. This prevents any extra thickness of joints in the fire, and this is the only place where trouble would otherwise be expected. The theory of the transmission of heat shows that thick plates offer practically as little resistance to the flow of heat as thin ones, a change from ⅝ in. to ¾ in. only increasing the resistance 1 per cent. The resistance comes almost wholly from the dirt on the surfaces, and that on the outside is a safeguard. The covering of the underside of the bottom of a horizontal tubular boiler with soot which is never removed, has slight effect upon the efficiency of the boiler, because it contains only about 5 per cent. of the heating surface of the boiler, and because being in contact with the hottest gases of the fire it no doubt absorbs more heat than any other equal area of surface.

The claim that horizontal tubular boilers for high pressure have their pressure reduced in a few years is not true if they are properly designed, unless, of course, a case of corrosion occurs. Such corrosion is as likely to be found in the drum of a water tube boiler and should be as much of a cause for reduction of pressure.

Effect of Brick Work on Economy.

The effect of brick work on boilers is often bad from the effect of cracks, which are sure to come. The cracks allow air to enter and cool off the gases. They should be looked for and stopped up with mortar immediately. Air leaks not only injure economy, but are a tax on chimneys to carry off the surplus gas. A person who has not looked into the effect of this source of loss would be surprised to know how great it is. It often is misleading in a way, for it produces low gas temperatures which are interpreted as a merit of the boiler, while it is really a demerit. From this source of inefficiency the locomotive or other internally fired boiler is exempt, and this is one of the sources of its economy. The other source is small radiation.

Air Leaks and Economizer Efficiencies.

There is often a disappointment in the effect of economizers. This is in part due to low flue gas temperatures caused by air leaks in brick work. Internally fired boilers will generally give higher gas temperatures in the flue on account of their being normal and un-reduced by air. A combination of such a boiler and an economizer in the flue gives a greater efficiency in general than that of a bricked-up boiler and an economizer.

Return on Investment.

This is a proper place to consider what sort of a return should be looked for in considering the adoption of a higher-priced article than a standard article, in this case the adoption of a water tube boiler rather than the common tubular. It must yield some profit to justify the extra investment, and the mere payment of the interest on the extra investment is not enough, for it is evident that then a company would be not only no better off than before, but even worse off. On careful consideration it will be found desirable that the saving should be at least three times the interest on the extra investment. If this is so how can an investment in an expensive inferior article be justified?

An Inertia-Valve Percussive Tool.

Under the above title a paper was recently read by Mr. Chester B. Albree before the Engineers' Society of Western Pennsylvania. The paper dealt at length with applied mechanics in tracing the conception and development of hammers. The scope of the paper includes the hand hammer, the ancient catapult and practically every conspicuous step of advance that lies between those primitive appliances and the modern compressed air hammer. Leading thus with the classification of various methods of applying the force of a hammer blow, citing types of hammers of various design, commenting upon principles involved and results attained, the author reaches the consideration of automatic control of fluid-driven percussive tools. Extracts from this paper follow. Methods of automatic control are classified under three heads, namely:

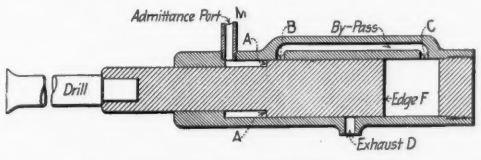


Fig. 1.—Darlington Valveless Drill.

First—The tappet valve type in which projections attached to the reciprocating part strike triggers or other devices which in turn move the valve.

Second—The fluid-moved valve type, wherein the piston itself, at certain parts of its travel, admits a supply of motive fluid to move the valve or to move a supplementary piston, which in turn moves the valve.

Third—The so-called valveless type, in which the moving piston acts as its own valve, as in its stroke it alternately opens and closes certain ports, so that fluid acts on each end of the piston in turn.

The progenitor of this type was invented by John Darlington, May 13, 1873, in England, and a great many were used, although now superseded by the modern drills of the first and second types described. The Darlington valveless rock drill is shown in Fig. 1.

In this machine the motive fluid acts constantly on the smaller area of the piston. When the piston is at the outer end of its stroke the space in the rear is open to

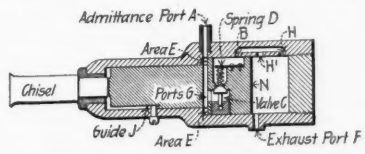


Fig. 2.—A Poppet-Valve Type.

the atmosphere, and the constant pressure on front area forces the piston back. In its motion it closes the exhaust port and a back cushion is started in the rear. At a certain distance, before the motion of piston is entirely checked by the cushion, a by-pass leading from front to rear end of cylinder is opened, this by-pass being a little longer than the main body of piston. Fluid rushes through this passage to the space in rear of piston, pressing on large diameter of same with initial pressure, drives piston forward against the pressure on small diameter with a force due to the excess of area under the same pressure per sq. in. Very early in the down stroke the by-pass is closed again by body of piston, and further force is derived only from the expansion of the body of high pressure fluid, locked in the rear of piston.

Against this decreasing pressure of expansion is opposed the constant pressure on the small front area, so that the net forward force is constantly decreasing, although sufficient, combined with the momentum already acquired, to propel piston in its entire stroke with considerable velocity, utilized in effective work on the object

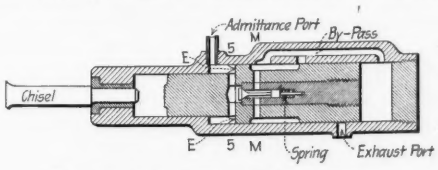


Fig. 3.—Axial Poppet-Valve Hammer.

struck by the tool. When nearly at end of out stroke the exhaust in rear is again opened, so that farther travel is entirely due to the acquired momentum. As soon as the blow is struck the piston is stopped, and immediately is pushed back by pressure on front area and the operation repeats. The conception is unique and beautiful, the drawback being the loss of velocity on the out stroke, as described. The action of this tool has been explained in detail, as it was in the endeavor to overcome this defect that experiments and study were made of the problem.

In Darlington's drill the initial pressure was used for the back stroke, and the expansive force used for the out stroke. April 13, 1880, William L. O'Neill took out a United States patent for a valveless rock drill reversing this action, so that the effective out stroke was due to initial pressure and the return stroke to expansion. This device never was used practically, as far as can be ascertained, probably due to the fact that a cushion was formed in front of the piston when the exhaust was closed, increasing in force as the piston progressed and decreasing in velocity thereof. Having thus examined the three principal types of valve motion in ordinary use, we come to the development of the pneumatic hammer, which consists essentially of a small portable cylinder, in which a piston reciprocates very rapidly, striking a great number of blows per minute on the end of a tool inserted in the end of the cylinder. They belong to the

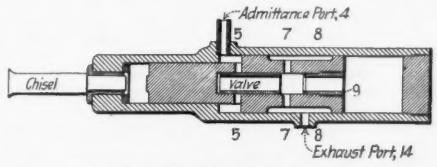


Fig. 4.—Direct-Acting Inertia-Valve Hammer.

second class of percussive tools, having a tool interposed between the hammer and the work.

McCoy may be said to be fairly entitled to the credit of the first application of such tools to heavy work, such as chipping metals, caulking boilers, cutting stone, etc., that had been done previousy by hand and hammer. He exhibited his device before the Franklin Institute, which awarded him a medal for a new and meritorious invention of real utility. He was not, however, the originator of the broad idea, as, long before he perfected the tool for heavy work, it had been used as a dental plugger, a device working compressed air in a cylinder, so that a piston struck the end of a tamping tool used to insert gold into the cavities in teeth. There were several patents taken out for such tools and successful results attained in the seventies. The pneumatic hammers followed in a general way, the valve motions used in rock drills, with modifications adapted to smaller and more

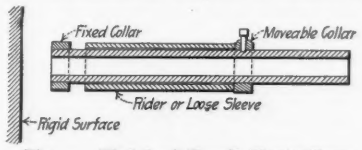


Fig. 5.—Model of Recoil Neutralizer.

portable tools. The valveless, as also tappet and fluid-moved valve, types are used.

Recalling the Darlington valveless rock drill, and referring to the drawing, Fig. 1, we notice that when the rear edge F of the piston passes exhaust port D on the back stroke that a cushion is at once started in the rear, increasing in pressure as the piston travels back. When the front edge A of the piston passes and opens the entrance B of the by-pass B-C, initial pressure air flows through admittance port M, cylinder cavity, and the by-pass to the rear of the piston immediately checking any farther movement and forcing the piston out, by reason of the greater area of surface F over surface A. In such forward movement the edge A again closes the port B of by-pass, cutting off the supply of further initial pressure air to the rear, so that any additional pressure or force upon rear area of the piston must be derived from the expansive action of the air locked in behind it, which, you will notice, is opposed by the initial pressure air bearing on surface A, which is constant at all points of stroke, either forward or back.

It seemed, on study of this device, that if some way could be found to allow air of initial pressure to follow

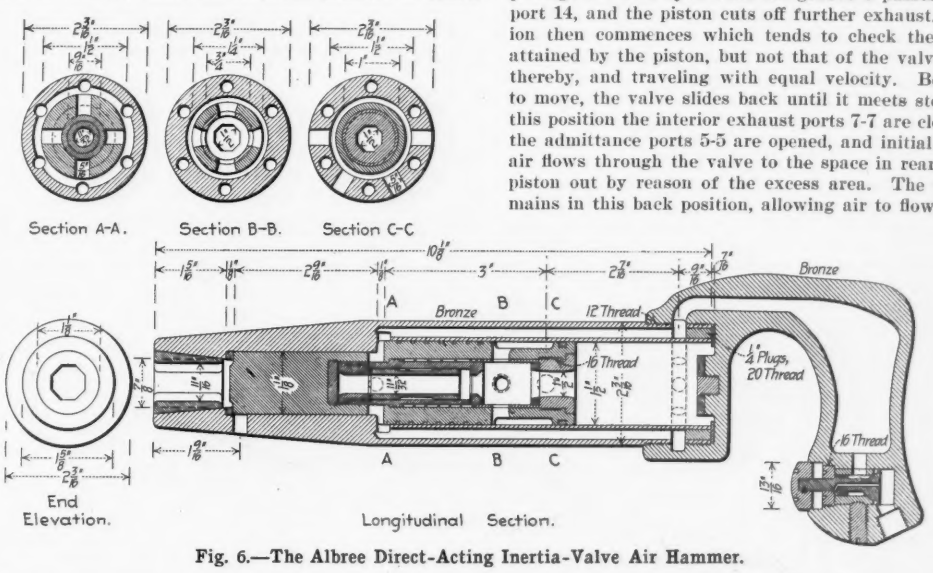


Fig. 6.—The Albree Direct-Acting Inertia-Valve Air Hammer.

up the piston during its entire downward stroke that much greater piston velocity would be secured. To accomplish this result, it was obvious that an automatically moved valve of some sort must control the flow of air in such a way as to prevent any access to the rear during the back stroke and to permit such access during the forward stroke.

The first solution that appeared was the use of a type of poppet valve, Fig. 2, with a spring bearing upon it, so that when there was no pressure on one side the valve would close under unbalanced pressure, but when the pressure was alike on each side the spring would force it open. To clearly understand it, referring to the print, A is a port admitting air continually against area E. G is a port leading from this area E to the valve chamber shown. C is a valve, with spring D bearing against the side of it, that is away from the constant supply of initial pressure in port G, arranged so that pressure against it from port G will close it against pressure of spring when no pressure exists back of it. B is a by-pass having two outlets communicating with cylinder, H and H'. F is an exhaust port, adapted to be closed and opened by the rear edge of the piston. J is a guide to prevent piston from turning, as the device as shown required that the valve cavity should not come in contact with the exhaust port F.

In action, air enters through A, pressing against small area E, closes valve C, and forces the piston back, the space in the rear of piston and in the by-pass and valve cavity having exhausted through port F. When the piston travels so that the edge E passes port B, air at high pressure goes through by-pass to rear, and at the same time through the port H into the valve cavity, thus equalizing the pressure on the sides of valve C, which opens under the pressure of the spring D, permitting free passage of the air through port G and the valve cavity, port H and by-pass to the rear, forcing the piston out, owing to the excess area. As it travels out this passage, either through B or H, is continually open, so that a continuous current of air flows through the valve at initial pressure, until the exhaust port is opened at F, reducing the pressure in the rear, when the valve again closes and the action is repeated as described.

When the spring C was exactly right in intensity for a given air pressure it worked nicely, but any variation of pressure interfered with good results. Again, the rush of air through the valve had a strong tendency to close it, requiring a superfine adjustment of the intensity of the spring. For static pressure, the idea was all right, but for dynamic pressure, if one could so call air under pressure in motion, it was not all that could have been desired.

A rearrangement of the parts was made, as shown in Fig. 3, an axial poppet valve type. The poppet valve was placed in the axis of the piston, which did not then require guides to keep it from turning, and the construction was simpler. Results somewhat better than in the first machine were attained, but it was discovered that the inertia of the poppet valve interfered with the contemplated action of the device. This movement of the valve by inertia suggested the use of a form of slide valve that should be controlled entirely by inertia, opening and closing suitable ports in its travel to accomplish the desired ends.

A tool, as shown in Fig. 4, was designed, having an axial hole in the center, within which a small tube could move freely within fixed limits, thus forming a direct acting inertia-valve hammer. A constant supply of air is admitted at 4 against the small area of piston. Ports 5-5 lead from a point adjacent to this small area into the valve chamber, which in turn opens to the rear end of piston. An exhaust port, 14, leads through the cylinder and a groove around exterior of piston, communicated by a port, 7, to the valve chamber. In starting, the tubular valve is at the outer end of chamber, thus closing ports 5-5 and leaving ports 7-7 open. Owing to the constant pressure on the small area, and the exhaustion of pressure in rear of piston, it travels back, and the rear edge closes exhaust port 14, which, however, registers at the same instant with annular groove on piston, establishing a new means of exhaust through the valve chamber, ports 7-7 and annular groove 8 to port 14. This passage remains open until the groove 8 passes exhaust port 14, and the piston cuts off further exhaust. A cushion then commences which tends to check the velocity attained by the piston, but not that of the valve carried thereby, and traveling with equal velocity. Being free to move, the valve slides back until it meets stop 9. In this position the interior exhaust ports 7-7 are closed, and the admittance ports 5-5 are opened, and initial pressure air flows through the valve to the space in rear, driving piston out by reason of the excess area. The valve remains in this back position, allowing air to flow through it until the piston has struck its blow, when the valve slides, by reason of its inertia, to its outer position, and the action repeats as described.

The tool worked very well at times, but it was discovered that the valve had a strong tendency to bounce back, especially on the front stroke. This unlooked for movement of the valve had very disastrous effects, as may be imagined, causing the action to be extremely erratic. To obviate this trouble, brakes were applied to the valve to prevent its sliding so easily. The machine ran well when it got a good start, but the valve was liable to stick at the wrong end of the chamber, and there was great difficulty in starting again until the piston had been jarred by hand so as to bring the valve where it should have been.

In pondering over the failure, the idea of counter-bal-

ancing the rebound of the valve by a smaller mass colliding with it at the instant rebound commenced arose. A little model, Fig. 5, to test recoil neutralization, consisting of a pipe, with two collars fastened to it, having between them another piece of pipe, large enough to slip freely on the outside of the other, and a little less in length than the distance between the collars, was made. It seemed as if this principle could be applied to the valve, so as to overcome its rebound and at the same time give the freedom of motion necessary to good action. A modification of the valve was made with a rider attachment, which, when tried, caused the tool to work with the regularity of clockwork.

The latest model of a direct acting chipping tool is shown in Fig. 6, a 1½-in. direct acting inertia-valve hammer. You will note that the valve will move at any point of the stroke, if the velocity of piston be checked, and that within the limits for cushion described earlier in this paper the stroke is variable. While this variability of stroke is not so essential in a chipping hammer, or any tool of the second class of percussion, where an interposed tool receives the blow, yet for machines of the first class, such as rock drills, steam hammers, gold mine stamps, etc., such variability is essential to attain the best results. In this hammer the exhaust takes place at very nearly the initial pressure, hence a great deal of energy contained in the compressed air is wasted, although the piston velocity on the down stroke is great, giving a powerful blow.

Other parts of the paper treat of percussion and rebound, action and reaction, as observed with contacts of various substances, covering a wide field of experiment. A compound inertia-valve hammer is also illustrated and described therein.

New Shops and Yards of the Colorado & Southern Ry.

The Colorado & Southern has begun work on locomotive and car shops, roundhouse, coaling station, etc., at Denver, Col., which will be done by about October 1, and in these shops will be done all the heavy repairs for 144 engines and 100 passenger cars, in addition to the freight car repair work in the adjacent yards. Heretofore this road has leased shops at Denver from the Union Pacific, and these will be remodeled and used by the Pullman Co. The Colorado & Southern has small shops at Pueblo and Trinidad, where light repairs are made, but the bulk of the work for the entire road, over 1,000 miles, will be concentrated at Denver. Mr. H. W. Cowan, the Chief Engineer, in anticipation of this work, has made a special study of railroad shop design and the new Denver shops may be taken as an example of good practice.

The buildings without machinery and the shop yard proper (north of the switching yard as shown on the general plan, Fig. 1) will cost $260,000, and the machinery will cost $90,000 more, making the total cost $350,000. Considerable filling was needed to bring the grounds up to grade, the fill averaging from 6 to 7 ft. The switching yard was built last year and the shops are well placed for repairing freight cars, being close to the transfer tracks of the Burlington & Missouri River, and the Atchison, Topeka & Santa Fe; and they are convenient to the main tracks and Union Depot. In using the old Denver shops, engines had to be run between three and four miles in going from the roundhouse to the station, and the new location will reduce the dead mileage of passenger engines. Also, the roundhouse is just opposite the yard in which freight trains are made up, and there are three tracks leading from the roundhouse to this yard. Freight engines will, therefore, make practically no dead mileage, and there will always be a clear track from the roundhouse, avoiding delays.

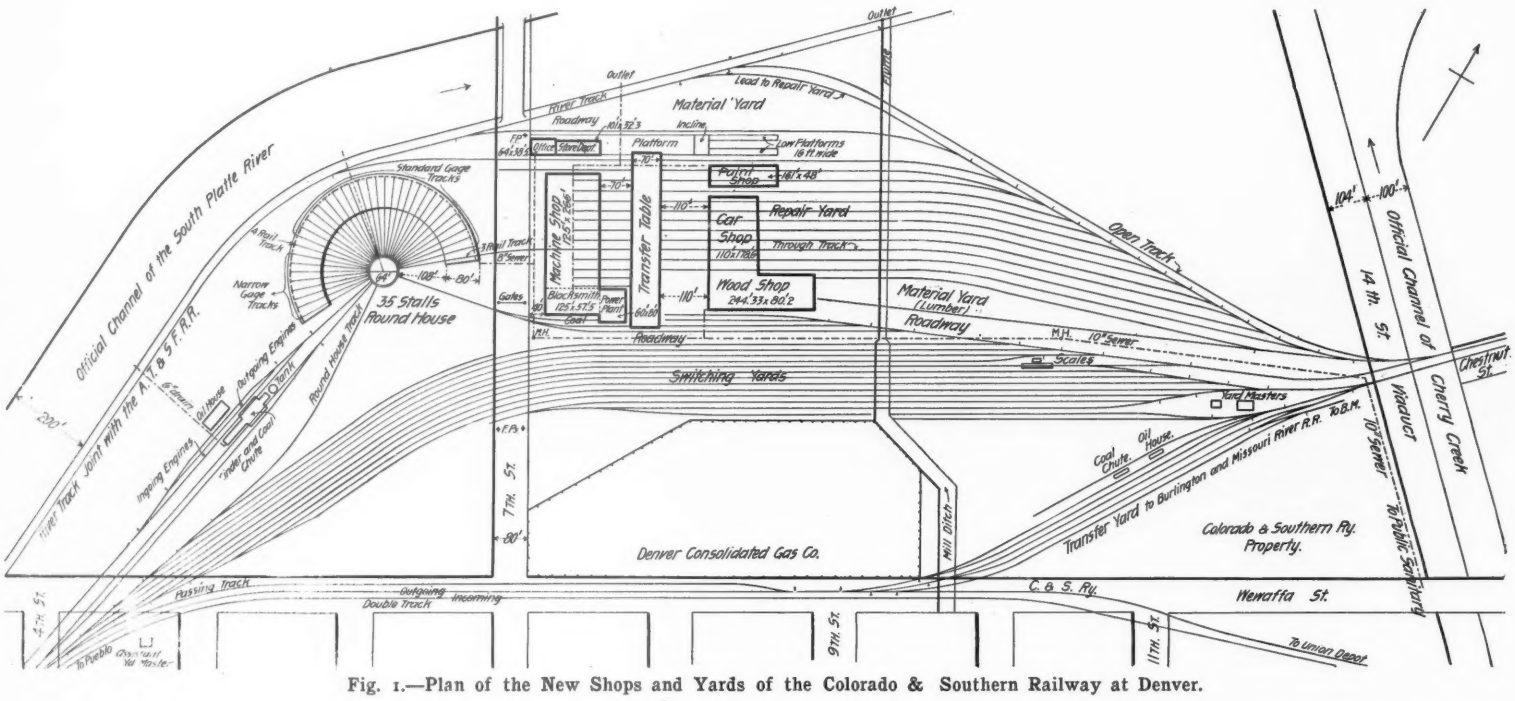


Fig. 1.—Plan of the New Shops and Yards of the Colorado & Southern Railway at Denver.

Reference to the plan, Fig. 1, will show that the grade crossing at Seventh Street was one of the first things to be considered in the arrangement of the buildings, and the location of the roundhouse and shops on opposite sides of this street was selected as the most suitable. It is intended that little repair work shall be done in the roundhouse that will require much carrying of material from the shops. The ingoing tracks to the roundhouse are on

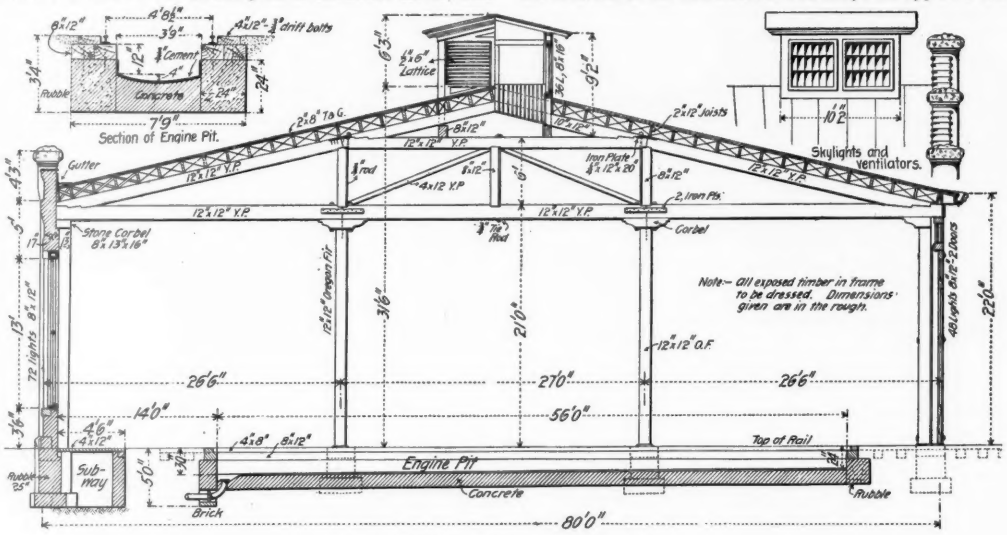


Fig. 6.—Section Through Round House.

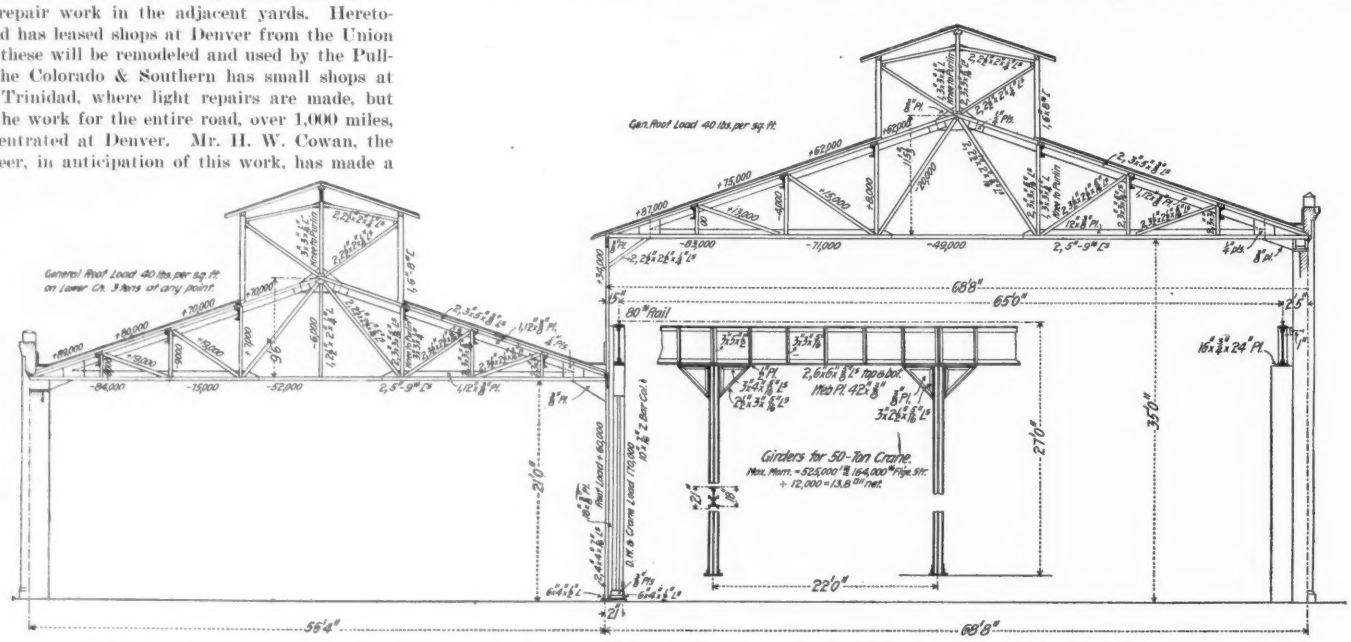

Truss for Machine, Blacksmith Shops and Part of Boiler Shop.
Truss for Erecting Shop and Part of Boiler Shop.
Girders for 50-Ton Crane.
80" Rail
68'8"

Fig. 3.—Steel Work.

either side of the coaling and water station, and the cinder pits are on these tracks. It is probable that the ashes and coal will be handled at this station by mechanical conveyors.

The machine and erecting shop is on the side of the transfer table toward the roundhouse, while the paint shop, car shop and wood shop are on the opposite side near the freight car repair yard. This yard has a capacity of 300 cars, the tracks are 22 ft. center to center, and are arranged for both standard and narrow-gage equipment; there are in all about six miles of shop tracks. At the end of the transfer table is an elevated platform adjacent to the storehouse and material yard. Supplies from the storehouse can therefore be handled by the transfer table, and material from the yard can be handled in the same way; or it may be loaded on cars and switched into the shops. The lumber yard is at the end of the wood shop and has throughout a system of tracks for push cars that lead into that shop. Coal can be unloaded from cars into the blacksmith shop and power house without further handling. There are ample sewers and water mains, and the shops and yards will be lighted by electricity.

All the buildings will be of pressed brick with stone trimmings and the foundations will be rubble masonry walls on concrete footings. They will all present a similar appearance, as the same lines have been followed throughout and no attempt has been made to provide elaborate decorations. The ornamentation is simple and well suited for shop buildings. The plans show ample windows and skylights and all the buildings will be well lighted, particularly as the atmosphere of Denver is remarkably clear. The roundhouse has a wooden truss roof, but all the shop buildings have steel roof trusses, giving a clear floor space below. The roof covering in all cases consists of tongue and groove sheathing covered with "Elaterite," a plastic roofing made at Denver and used with good results by the road heretofore.

The floor plan of the locomotive shop is shown in Fig. 2, which also indicates the arrangement of the roof trusses. These are given in detail in Fig. 3, a section through the middle of the building, and the trusses there shown are representative of the roof construction in general. This building is 323 ft. 6 in. long by 125 ft. wide. At one end is the blacksmith shop, 57 ft. 6 in. by 125 ft. and opening off from it are two bays, each 198 ft. long, with a row of steel posts between; one bay, the erecting shop, is 68 ft. 8 in. wide and the other, the machine shop, is 56 ft. 4 in. wide. At the far end is the boiler shop extending the full width of the building, and it has no increased head room as the riveting is to be done with pneumatic tools. The power house adjoins the blacksmith shop. A 50-ton electric traveling crane serves the 12 pits in the erecting and boiler shops, and is shown in Fig. 3. The span is 65 ft. center to center of track girders, the height of the track rails above the floor is 27 ft., and it will be noted that the portion of the building served by the crane has 14 ft. greater head room than the other parts. There are no galleries and the tool room is an offset so placed as to serve both the machine and boiler shops. It will be seen that, in addition to the overhead crane, shop tracks run through the building, with a turntable at the center, connecting the various departments. These tracks have four rails, for standard and narrow gage trucks. The pits also are arranged for engines of both gages, there being two narrow gage pits, four four-rail pits and six standard gage pits. The construction of the pits is shown in Fig. 4. The table gives a list of tools referred to by numbers in Fig. 2.

Key to Tools Shown in Fig. 2.

Name of Machine.	No.	Counter Shaft. Pulleys. Diam. In.	Width face. In.	Rev. per minute.
Machine Shop.				
Fox turret lathe....	1	10	3	150
Bolt cutter, single head	2	16	4	225
Screw cutter	3	11	5	125
1½-Spindle nut tapper, 6 spindle.....	4	16	4	300
22-in. Planer	5	12	4	235
60 x 60 in. Planer....	6	24	6	215
18-in. Shaper	7	22	8	90 and 170
Surfacer	8	6	3½	300
Emery wheels	9	8	4½	600
40-in. Upright drill..	10	14	4	175
28-in. Upright drill..	11	12	4	160
Emery wheels	12	8	4½	600
Horizontal boring machine	13	22	5	75
Hydraulic driving wheel press, 300 tons capacity.....	14	36	6	100
21-in. Upright drill..	15	9	2½	300
16-in. Lathe	16	10 and 12	3½	160
14-in. Lathe	17	10 and 12	3	170
12-in. Lathe	18	10	3	180
14-in. Lathe	19	10 and 12	3	170
21¼-in. Turret lathe	20	20	5¾	85-125
72-in. Boring mill...	21	20	4½	175
Grindstone	22	..	..	..
16-in. Lathe	23	10 and 12	3½	150
24-in. Lathe	24	20	5¾	85-125
30-in. Lathe	25	20	7½	85-125
30-in. Lathe	26	20	7½	85-125
42-in. Lathe	27	26	9	90-125
60-in. Driving wheel lathe	28	36	6¾	80
84-in. Driving wheel lathe	29	36	6¾	50
84-in. Driving wheel lathe	30	36	6¾	50
Radial drill	31	16	4	160
18-in. Slotter	32	24	5	110-136
36-in. Planer	33	20	5	200
54 x 54-in. Planer	34	20	5¾	235
Sensitive drill	35	6	2½	425
Car wheel lathe, 42-in.	36	28	6½	90
Blacksmith and Boiler Shops.				
Bulldozer	43	30	10½	33
Pressure blower, No. 8	44	..	..	..
Bolt-header	45	12	8	210
Power shears	47	30	6¼	175
Double-head bolt cutter	50	16	4	225
Rolls	51	36	6	190
Shearing and punching	52	30	6¼	175
Tool Room.				
Reamer, cutter and grinder	57	..	..	..
Universal tool grinder	58	8	3¼	525
Drill grinder	59	8	4	560
Sensitive drill	60	6	2½	425
Wet grinder	61	8	3¼	525
12-in. Lathe	62	10	3	180
16-in. Lathe	63	10 and 12	3½	160
Milling machine	64	12	4	145

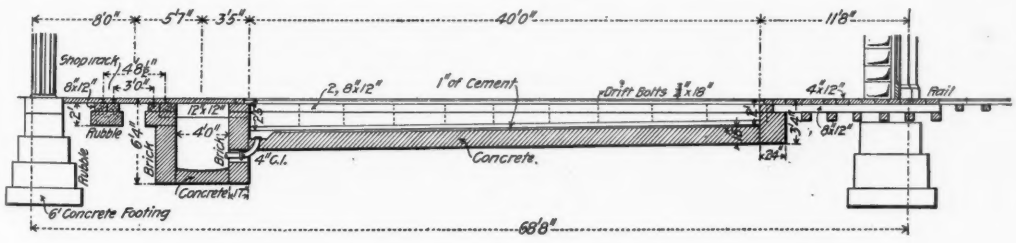


Fig. 4.—Erecting Shop Engine Pits.

Fig. 5 (p. 396) is a plan of the wood shop, giving the arrangement of the machinery. This is a one-story building, 80 ft. 10 in. wide by 244 ft. 4 in. long, similar in construction to the machine shop. The arrangement of the shop tracks is also shown, and it will be seen that these are so arranged that the material can be carried from the yard through the shops from one machine to another, and, by means of turntables, along the tracks at right angles into the car shop. The car shop is 110 ft. wide and 179 ft. 7½ in. long and differs from the other buildings only in being two stories. On the first floor are eight repair tracks running through the building, and as these are 110 ft. long there is room at each end for tracks from the wood shop, which run at right angles to the main tracks, and form an easy way of bringing in materials. In addition to the side windows this floor is lighted by a 30 x 130 ft. well at the center. The clear head room in this shop is 20 ft. On the upper floor, which surrounds the light well, is the foreman's office, upholstering room and tin shop, and in addition space is provided for storing finer materials used in passenger cars. An elevator serves this store room. The tools shown by numbers in Fig 5 (on the next page) are listed in the table.

Key to Tools Shown in Fig. 5.

Name of Machine.	No.	Counter Shaft. Pulleys. Width face. Diam. In.	Rev. per minute.
Wood Shop.			
Bolt cutter double-header....	1	16 4	200
Planer, four-side	2	16 10	775
Circular saw, 12-in.....	3	8 5	645
Vertical driller	4	12 6	310
Planer	5	14 8	480
Planer, long bed.....	6	12 6	520
Jointer	7	10 4	780
Hollow mortiser	8	12 8	560
Car wheel boring machine..	10	26 6	95
Car wheel grinder.....	11	18 6	50
Hydrostatic wheel press, 200 tons' capacity	13	36 6	100
Axle lathe, double head.....	14	18 4	160
Axle lathe, double head.....	15	18 4	160
Bolt cutter, double head....	16	16 4	200
6-Spindle nut tapper.....	17	16 4	300
Upright, 24-in. drill.....	18	10 3	275
Grindstone	20	4 5	50
Car sill tenoning machine...	21	24 8½	600
Band re-sawing machine B3.	23	20 5½	550
42-in. Rip saw.....	24	16 6	500
Greenlee, No. 2, self-feed, 24-in. saw	25	8 8½	1,800
Greenlee, No. 1, automatic cut-off	26	10 5½	750
Greenlee, No. 3, automatic cut-off machine	27	14 10½	375
Horizontal boring machine, 4-spindle	29	14 8½	300
Greenlee, No. 2, car gainer..	30	14 10½	375
No. 4 hollow chisel mortiser.	32	10 5½	1,000

The paint shop is like the other buildings in the matter of foundations, walls and roof, is one-story high and 160 ft. 9 in. long by 48 ft. wide. There are two longitudinal car tracks running through this shop, and the floor is concrete, in which wash gutters are formed. At one end there is a gallery used for a paint room, which is 16 ft. wide by 24 ft. long; this room is reached by two flights of stairs. It is proposed at some future time to extend this building 96 ft. toward the transfer table, which would make the total length 256 ft. 9 in.

The approximate floor space in the several shops is as follows:

Blacksmith shop	6,777 sq. ft.
Machine shop	13,315 sq. ft.
Erecting shop	10,890 sq. ft.
Boiler shop	8,191 sq. ft.
Wood shop	18,837 sq. ft.
Car shop (first floor)	19,153 sq. ft.
Paint shop	5,259 sq. ft.

The transfer table pit is 385 ft. long by 70 ft. wide and the walls are rubble masonry on concrete footings, capped with 6 x 12-in. yellow pine timbers. The pit will be shallow, so that it can be easily crossed. The transfer table will be operated by an electric motor and a third rail will be used.

A section through the roundhouse is given in Fig. 6,

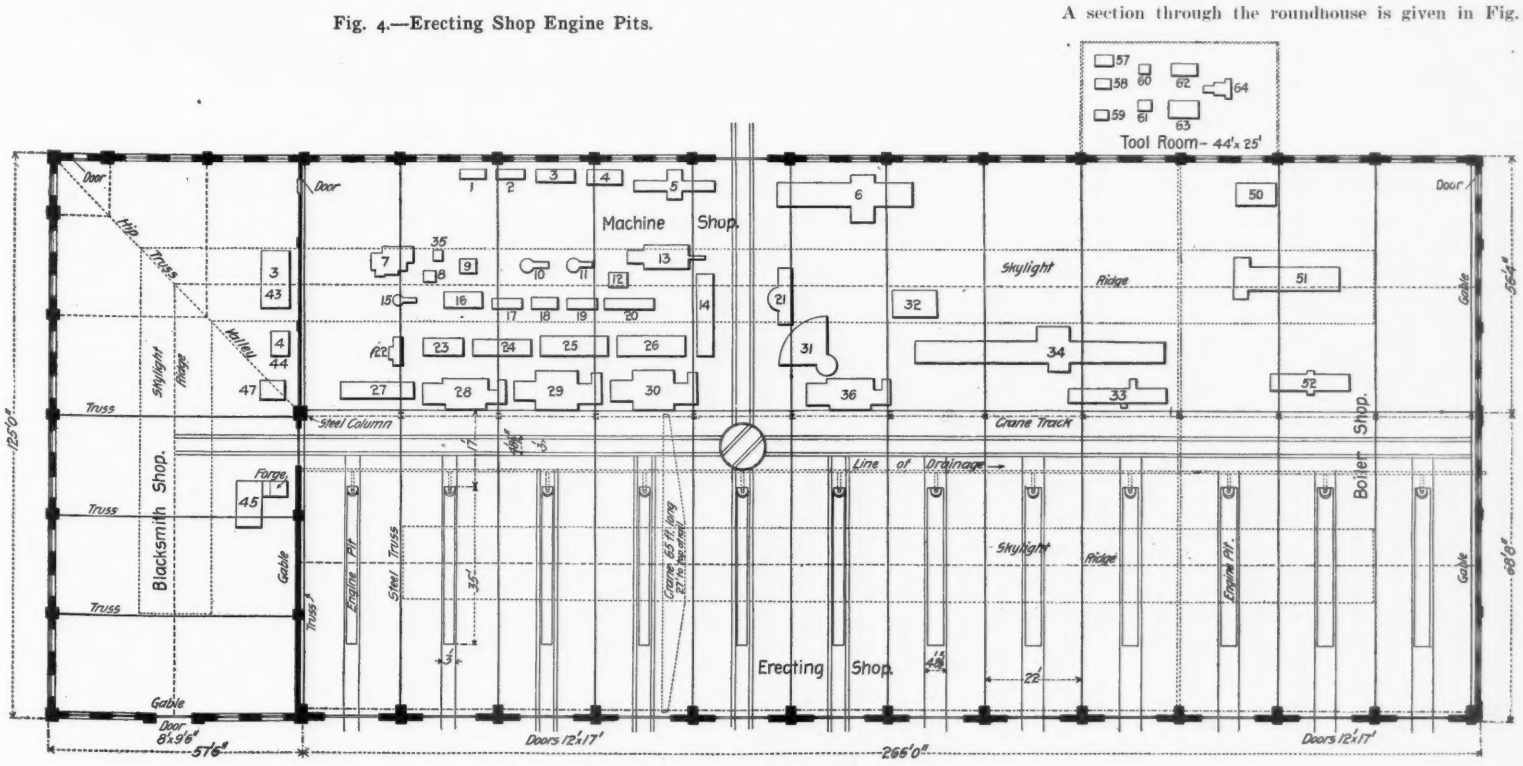


Fig. 2.—Plan of Locomotive Shop—Colorado & Southern.

showing the construction of the building, pits and subway. It will be seen that wood is used throughout instead of metal, and that the roof has a ridge at the center. The ventilators in the roof are not continuous, but, as shown, are in section, 10 ft. 2 in. long, one above each pit. Glass windows are placed in the sides and lattice work in the ends of each section; Pickering smoke jacks are used. The whole arrangement is designed to give better ventilation than is usually got in roundhouses. There are in all 35 stalls; eight having narrow-gage tracks; one has a four-rail track, 26 standard gage, and there is one three-rail track. Two drop pits are provided, one for standard and one for narrow-gage engines, and there are four fire walls. A Keystone turntable will be used, 64 ft. in diameter, probably operated by an electric motor.

In the power house will be one 150 h. p. Reynolds-Corliss engine which will drive the locomotive repair shop by line shafting. one 125 h. p. Reynolds-Corliss engine which will be belt-connected to one 85 kw. generator for lighting, and there will be one 250 h. p. Reynolds-Corliss engine belted to two 85 kw. generators, which will furnish current for power purposes. Machines in the wood shop will be driven by electricity, three machines being direct connected to individual motors, and the others being arranged in four groups connected by counter shafts and driven by motors of from 20 to 30 h. p. each. There will also be a small motor in the upholstery shop to drive burnishing and other light tools. The same engine which furnishes power for the wood and car shops will also supply current for operating the transfer table, the coal chutes and elevators, and the traveling crane in the erecting and boiler shops. A study was made of the machine

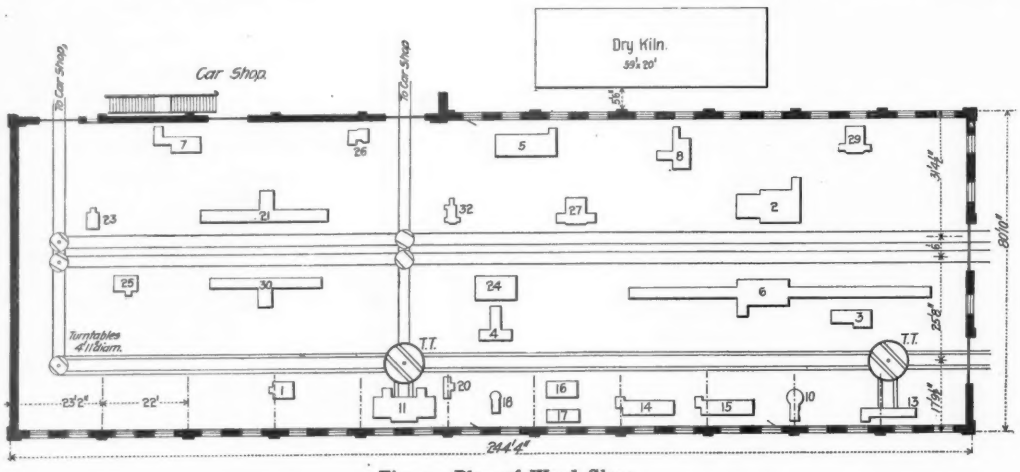


Fig. 5.—Plan of Wood Shop.

and boiler shops with a view to driving the machinery by electricity, but it was found that not enough shafting could be saved to warrant the additional cost. The system of heating is not yet decided, but will be one in which the exhaust from the engines is used. The E. P. Allis Co., Milwaukee, Wis., will furnish all the engines, boilers and shafting; the Western Electric Co., Chicago, the complete electric plant, and the Niles Tool Works, Hamilton, O., all the machine tools. The William J. Hill Co., Denver, Col., has the contract for erecting the buildings. All the steel work will be made by the Milwaukee Bridge & Iron Co., Milwaukee, Wis., and the railroad does the grading and excavating for foundations. We are indebted to Mr. Cowan for information and drawings.

Lubrication and Hot-Boxes.

BY H. B. HODGES.*

A great deal has been published about lubrication and hot-boxes, and the writer does not pretend to be able to contribute many new facts or theories bearing on this subject, but articles recently published have dwelt specially on one aspect or another, and there appears to be a field for a general résumé and systematic treatment of the whole topic of car journal lubrication and the prevention of hot-boxes.

Lubrication may be broadly defined as the means utilized to overcome friction, and in its application to railroad service the friction to be overcome is that of the axle journal and the brass bearing. Friction is produced when one surface moves over another, and is due to the resistance offered by minute protuberances (often microscopic) on one surface, to the passage over it of another surface with its frequently invisible projections, and is accompanied to a greater or less extent by the generation of heat. Friction between surfaces of the same kind of material is greater than between surfaces of different character, for the reason that the minute depressions and elevations in two surfaces of the same material correspond so closely that they fit into each other perfectly and become interlocked, or get into a condition of more perfect contact than is the case when material of one kind bears on material of a different character. For this reason partly it has been found desirable not to have the car bearing, as well as the journal, made of steel. These same protuberances, which it is assumed are present on what may appear to be a perfectly smooth surface, are also the cause of the production of more heat (due to a greater resistance) in sliding friction, that caused by the passage of one plane surface over another, than in rolling friction, the term used when one or both of the surfaces are spherical or cylindrical. This phenomenon is the reason for the use of wheels under cars and wagons instead of a support which does not revolve, as in sledges, and the theoretical explanation lies in the fact that in revolving, the little projections are lifted out of the corresponding depressions, as in cog-wheels, instead of breaking or bending as in the case of sliding friction.

An every-day illustration of the mechanical advantages of rolling over sliding friction is the use of rollers in moving heavy castings or stones, of the ball-bearings on bicycles, etc. This brings us to the subject of lubrication, which is nothing more nor less than the introduction, between the surfaces of two rigid bodies, of some material whose ultimate particles, or molecules, move so freely that they yield to the slightest pressure, and yet possess sufficient mutual attraction, or cohesion, to retain the form of minute globules and roll between the surfaces of the two rigid bodies they separate, thus acting as ball-bearings; and at the same time possess sufficient attraction for these surfaces, or adhesion, not to be forced out entirely by the pressure of the bodies they are to separate. Graphite, grease, oil and water are lubricants in a general sense, but the first has too much adhesion, and the last too little adhesion and cohesion to admit of any extended application in practice, although water would be of some slight value as a lubricant between two non-absorbent surfaces, where the pressure was trifling, for friction is directly proportional to the pressure of the two surfaces against each other. If the lubricant is absorbed by the surfaces it increases instead of diminishing the friction; thus graphite diminishes and oil and water increase the friction between wooden surfaces, while on metallic surfaces oil is the ideal lubricant, owing to the great mobility of its particles and to its possessing just the right degree of cohesion and adhesion, that is to say, the proper viscosity.

Assuming that in oil we have the best lubricant for car axle journals, the problem of overcoming friction and the resulting heating of the bearings, in other words, the prevention of hot-boxes, is not yet solved. There are other important factors to be considered, and for convenience the various causes of hot-boxes may be classified as follows:

1. Mechanical faults:
   - Pedestals out of line.
   - Brass or wedge put in wrongly.
   - Wrong brass.
   - Defective dust-guards and lids.
   - Rough or imperfectly aligned journals.
2. Oil:
   - Poor quality, or not proper consistency for the season of the year.
   - Badly prepared "dope."
3. Waste:
   - Poor quality.
   - Badly packed, too much or too little.
   - Neglect or improper care of the packing.
4. Brasses:
   - Wrong mixture of metals.
   - Bad foundry practice.
   - Rough bearing surface.

Mechanical Faults.—The false alignment of the pedestals, the use of the wrong brass, or a brass not put in properly, all cause trouble by violating the same principle of the laws governing friction, viz., the desirability of distributing the load over as large a surface as possible. Friction is directly proportional to the pressure, and the total amount of friction produced by one body moving over another is independent of the areas of the two surfaces in contact, but the friction on a given portion of these surfaces diminishes in direct ratio to the total area of the surfaces in actual contact, that is, the greater the number of points of contact between one body and that over which it moves, the smaller the friction on each of these points, although the total amount of friction between the two bodies as a whole is not affected by the number of these points of contact. Thus the sum of the friction produced by the weight of a car body on twelve bearings and journals is the same as when the car is supported on eight, but the amount of friction on each individual bearing and journal in the former case is only two-thirds of that in the latter.

Now if a car-brass, for any of the causes enumerated above, bears on the journal with only half of the area of surface which should be in contact, the friction on each square inch of the portion which does bear on the journal is twice as great as it should be, and the temperature of the parts in contact is correspondingly increased, frequently to the point of causing what is known as a "hot-box," the various degrees and manifestations of which condition are unfortunately too familiar to railroad men, and, I might add, to the traveling public, to require any description.

The mischief caused by the introduction of sand and grit between the bearing surfaces is, of course, thoroughly understood, and to avoid this efforts have been exerted to make the box as tight as possible through the invention and introduction on the market of various designs of dust-guards and lids, some of which have been accepted by railroad officials as meeting the requirements of service in a satisfactory manner, while others are still on an experimental footing. The importance of having journals free from seams or other defects, and turned smooth and true is obvious.

Oil.—In taking up the subject of oil it may be safely stated that its importance as a factor in determining the cause of a hot-box is no longer as great as it once was. The quality of the brasses has recently received a good deal of attention, and deservedly so, for the most perfect oil yet produced can not insure cool bearings unless all the other conditions are favorable. It is still of the utmost importance that the oil should be of good quality, and of the proper consistency for the season of the year in which it is used—that is, the oil should be thicker, as shown by its lower gravity, in summer, when the higher temperature of the air and bearings, in their perfectly normal condition, increases its fluidity and lessens its adhesion and cohesion, than in winter, when the oil should be thinner, or of higher gravity, to prevent it from solidifying from the low temperature, and failing to feed up to the journal through the waste with which the box is packed. While it is essential that the oil used as a lubricant should possess a certain amount of adhesion to the bearing surfaces, this should not be sufficient to prevent the free motions of its particles, as is the case when the oil is gummy or sticky; this undesirable attribute is due to the presence of tarry matter in the oil which is present in some oils more than in others, and has not been eliminated in the process of manufacture or purification. This tar may be detected by laboratory tests, some railroads using the gasoline test, mixing 5 parts by volume of oil with 95 of gasoline; others the sulphuric acid test, shaking up 25 parts by weight of oil with 5 parts of acid, the tar settling out at the bottom of the vessel in both cases, and it is advisable to make this with any new oil which the road may be thinking of using. A cold-test should also be made of oil intended for winter use. On some of the Western roads, when the cold is very severe in winter, an oil which will not congeal at 0° F. is specified, while on Eastern roads the limit is generally placed at +10° F.

The specific gravity of an oil, generally determined with a Beaumé hydrometer, and the flash test, do not conclusively prove that an oil is going to be entirely satisfactory as a lubricant, for two oils may resemble each other closely in these respects, and yet one oil may be a better lubricant than the other. The difference is due to their relative viscosity, which in one case may be greater than in the other. This viscosity is, as stated above, due to a combination of the properties of cohesion and adhesion, and is determined by mechanical tests, taking water as a standard of comparison. The most common method of making this test is to note the time it takes for a given volume of oil at a certain temperature to flow out of a small aperture, compared with the time it takes an equal volume of water to run out of the same receptacle—the simplest apparatus being a glass pipette such as is used in all laboratories—under the same conditions. Another method is to note the relative resistance offered by water and the oil to the revolution of a cylinder in the medium being tested.

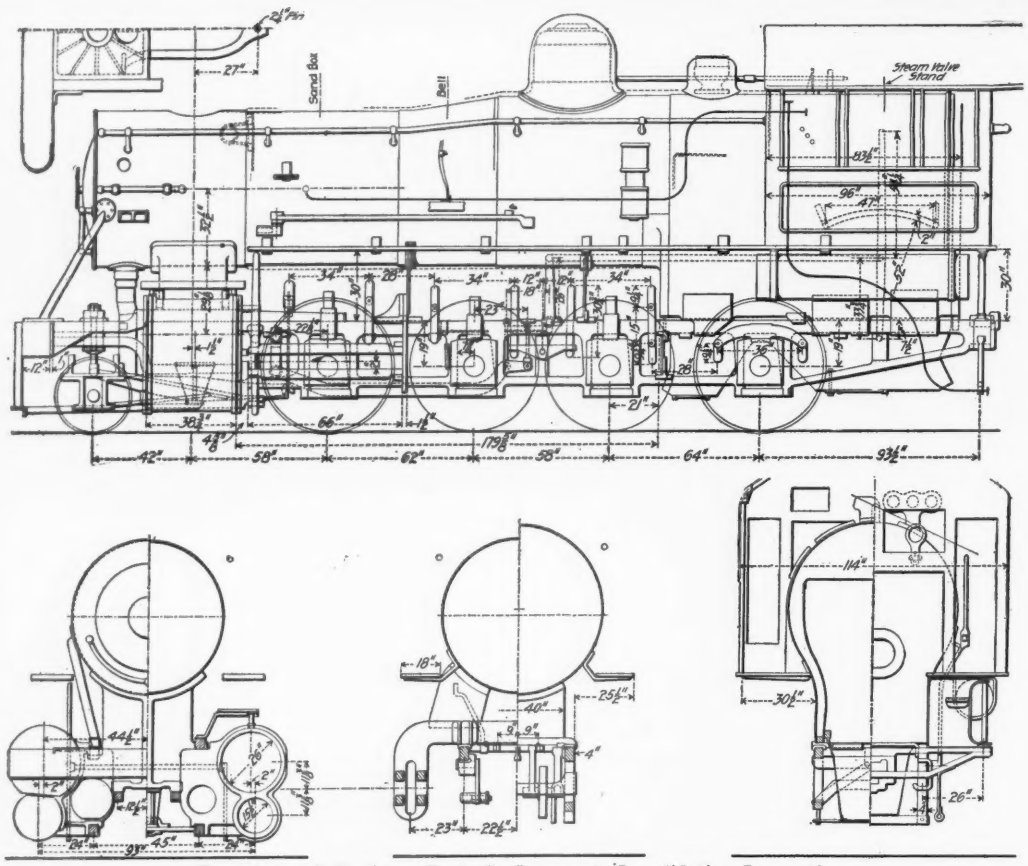
Waste.—In this country oil is generally put in the boxes in the form of a dope made by thoroughly saturating waste with it in a vat specially devoted to this purpose, the proportions of oil and waste and the duration of the saturation varying on different roads. The amount of oil absorbed or held by a given amount of waste depends partly on the thoroughness with which the dope is prepared, and partly upon the character and quality of the waste, and although cotton waste is used on some roads, the general practice being to use wool waste, this alone will be considered here. By a saturated waste should be understood a waste which has been soaked in an excess of oil, thoroughly stirred and "kneaded" and subjected to this treatment until it has taken up all it can, the superfluous oil being allowed to drain off without the application of pressure. Waste treated in this way and then wrung out by hand or by mechanical means should not be called saturated, although this practice is followed in some cases. There is a considerable difference of opinion as to the time during which the waste should be allowed to soak in the oil before it is used, some holding that 4 hours are necessary, while others consider 24 hours sufficient. To determine this point, as well as the amount of oil in thoroughly saturated waste, the following tests were made on the Long Island Railroad:

Three portions of waste composed of 75 per cent. wool and 25 per cent. cotton waste, each weighing 1½ lbs., were placed in earthenware jars and 8 pints Galena car-oil poured over each of them.

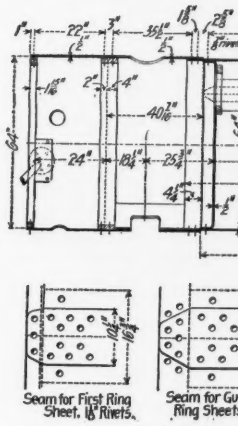
First Test: Oil and waste thoroughly mixed by stirring and kneading with a wooden paddle for a short time, then placed on a wire screen and allowed to remain so long as any oil ran through the meshes.

Second Test: Oil and waste thoroughly mixed as above,

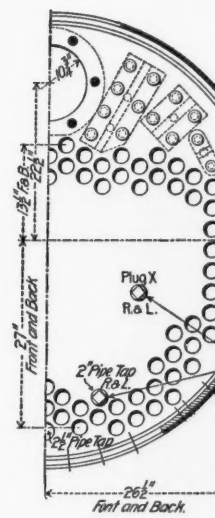
*Purchasing Agent, etc., Long Island Railroad.



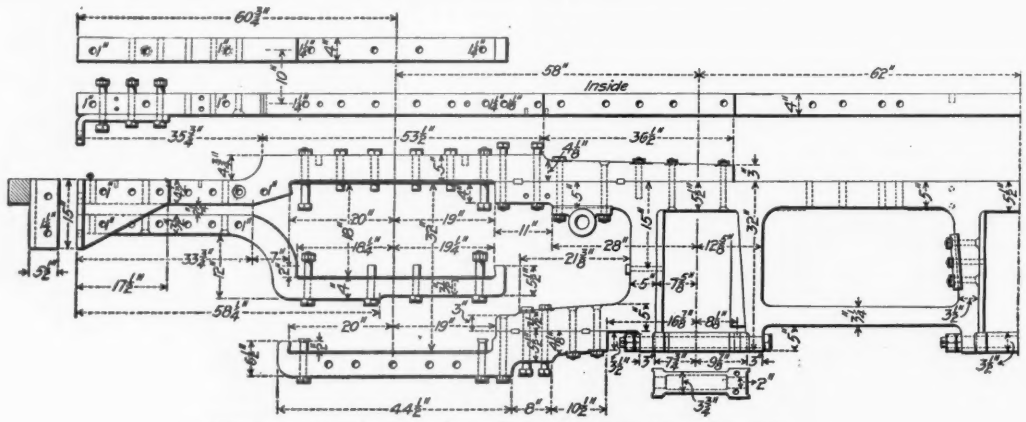
Elevation and Sections—B. & O. Compound Consolidation Locomotive.



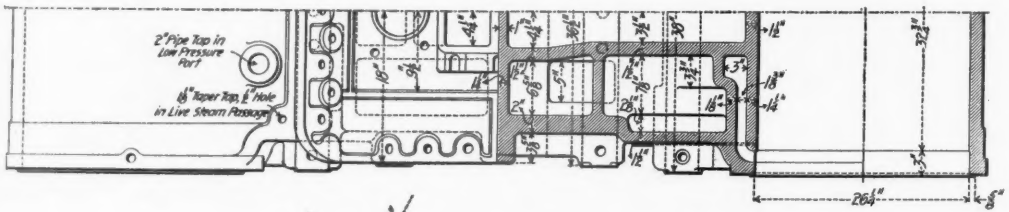
Extended W

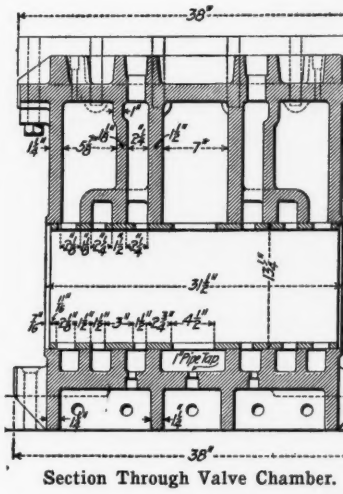


Cross Section

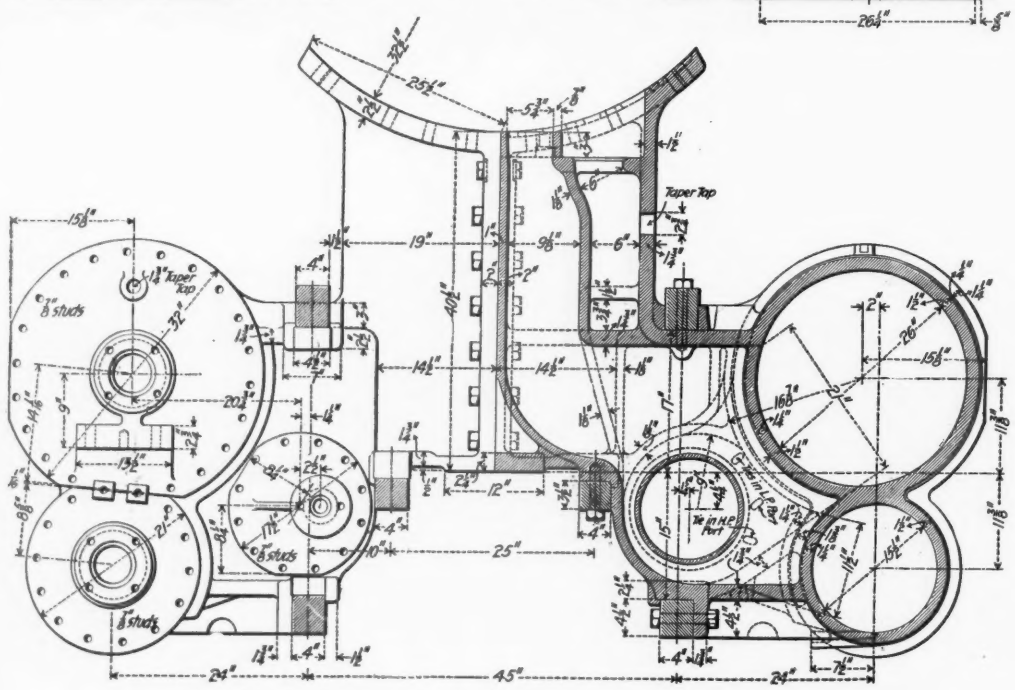


Cylinder Fastenings—B. & O. Comp. Consolidation Locomotive.

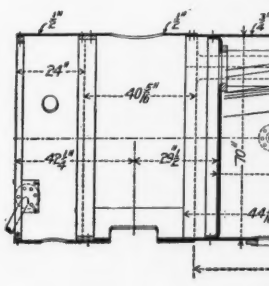




Section Through Valve Chamber.

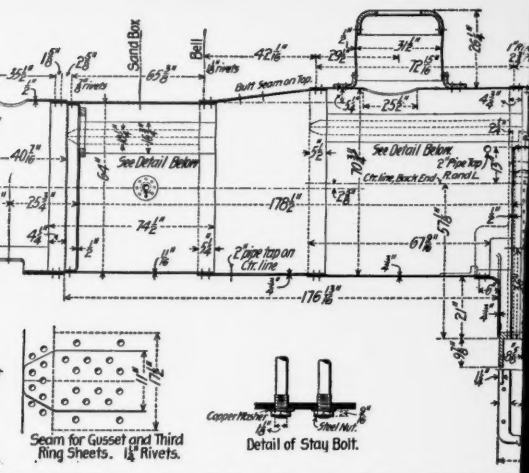


Cylinder Arrangement—B. & O. Compound Consolidation Locomotive.

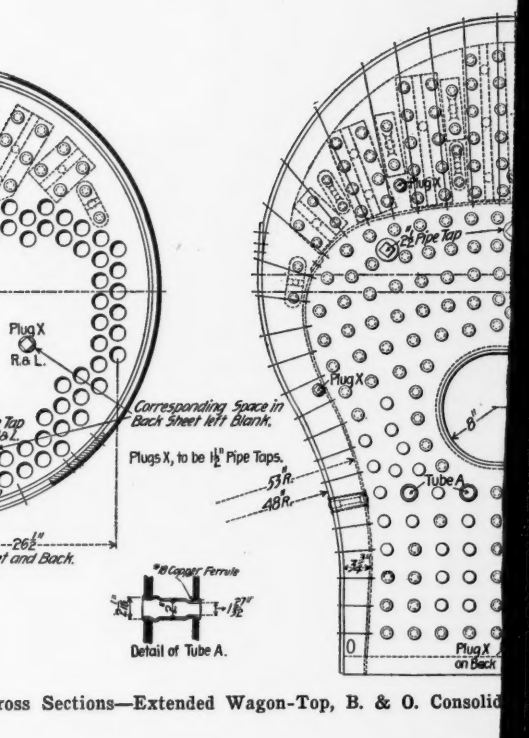


Wide Firebox Boiler-

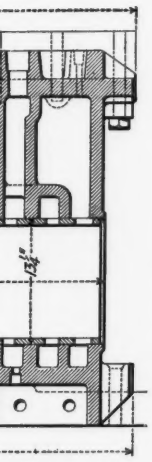
Cylinder 15½ in. and 26 in. x 30 in. **FOUR-CYLINDER COMPOUND CONSOLIDATION LOCOMOTIVE—BALTIMORE & OHIO RAILROAD.**



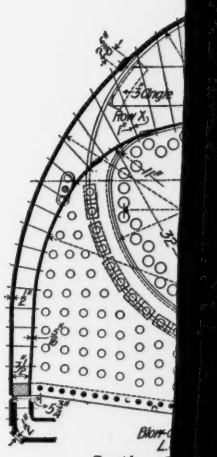
Extended Wagon-Top Boiler—Compound Consolidation L



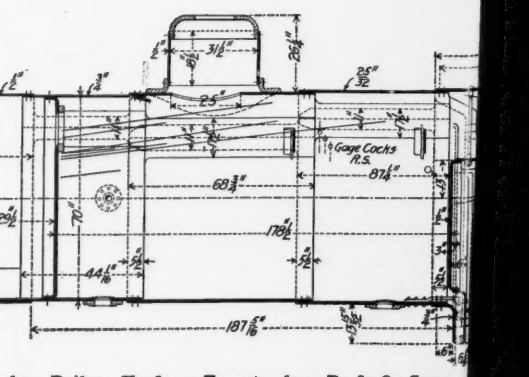
ross Sections—Extended Wagon-Top, B. & O. Consolid



e Chamber.



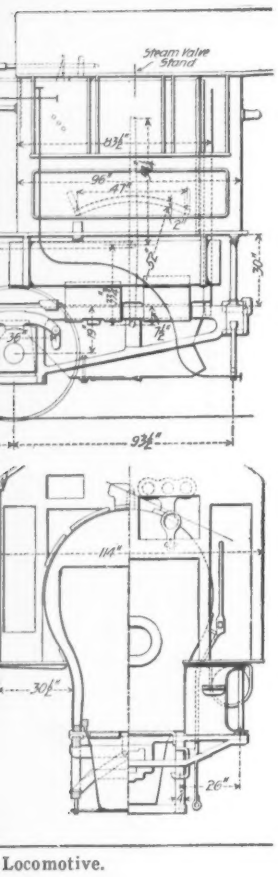
Sectional



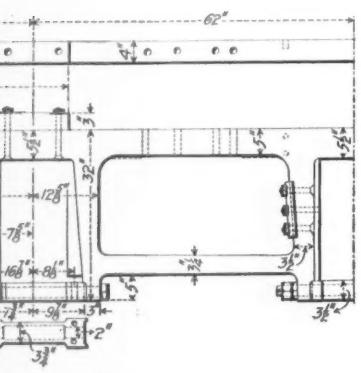
ebox Boiler—Used on Twenty-four B. & O. Compo

OAD.

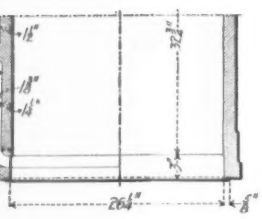
Built at the BALDWIN

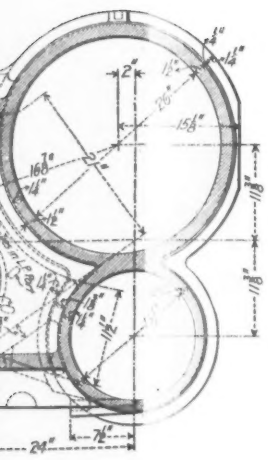


Locomotive.

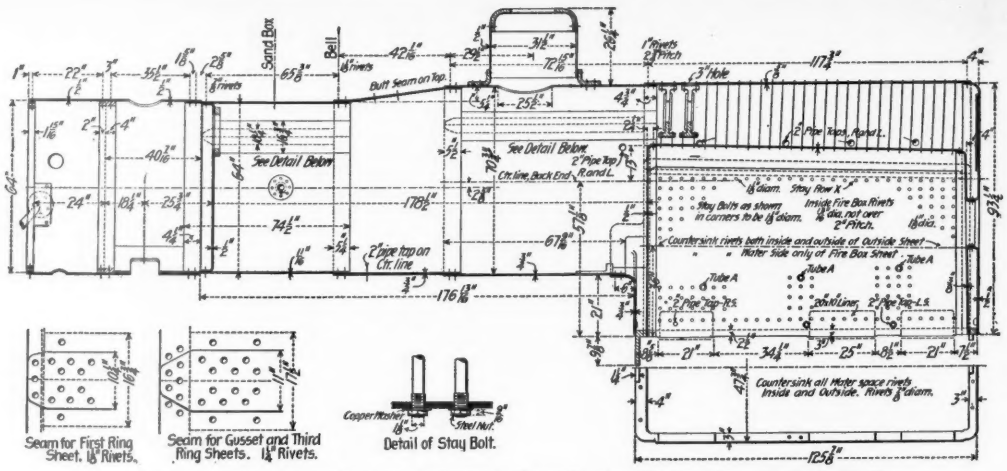


on Locomotive.

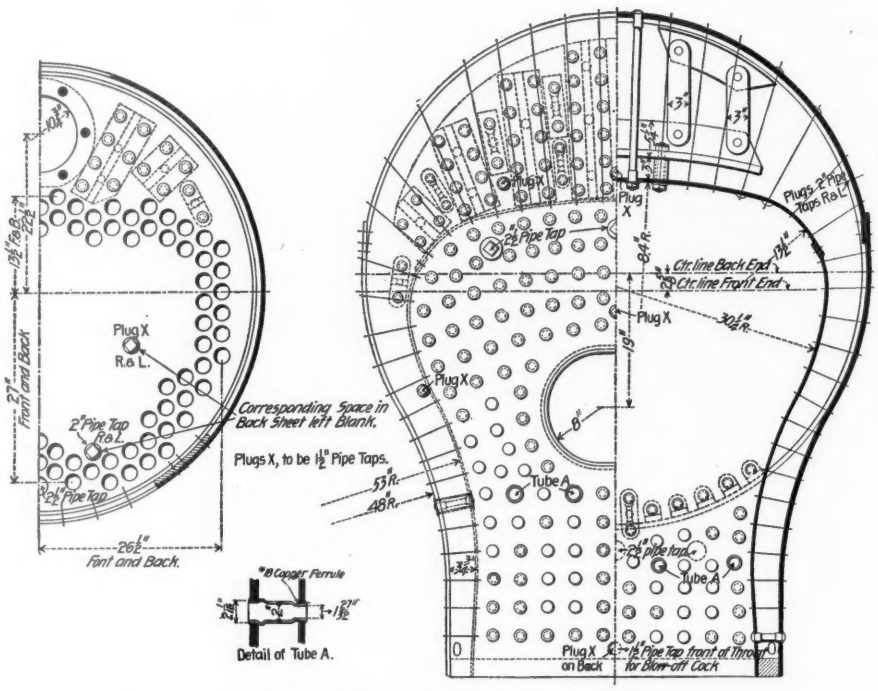




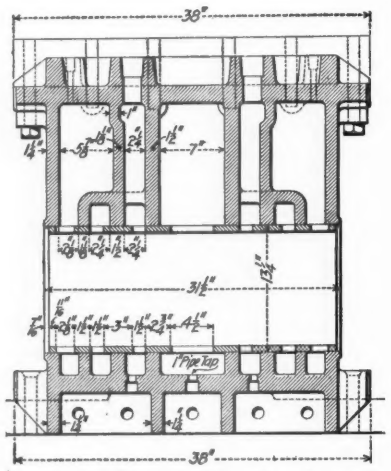
omotive.


Sand Box
Bell
Butt Seam on Top.
See Detail Below
2" Pipe Taps, Front L.
3" Hole
Stay Bolts as shown in corners to be 1⅛ dia., not over 2" Pitch.
Countersink rivets both inside and outside of Outside Sheet
Water Side only of Fire Box Sheet
Tube A
20x10 Liner
Countersink all Water space rivets Inside and Outside. Rivets ⅞ diam.
176⅛"
125⅞"
Seam for First Ring Sheet. 1⅛ Rivets.
Seam for Gusset and Third Ring Sheets. 1¼ Rivets.
Copper Washer
Steel Nut
Detail of Stay Bolt.

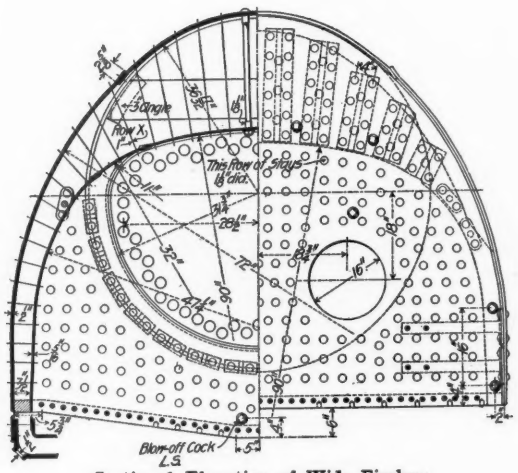
Extended Wagon-Top Boiler—Compound Consolidation Locomotive—B. & O. R. R


Plug X
R. & L.
2" Pipe Tap R. & L.
Corresponding Space in Back Sheet left Blank.
Plugs X, to be 1½" Pipe Taps.
Front and Back
Plugs 2" Pipe Taps R. & L.
Ctr. line Back End
Ctr. line Front End
Tube A
Plug X on Back
1½" Pipe Tap front of Throttle for Blow-off Cock
*8 Copper Ferrule
Detail of Tube A.

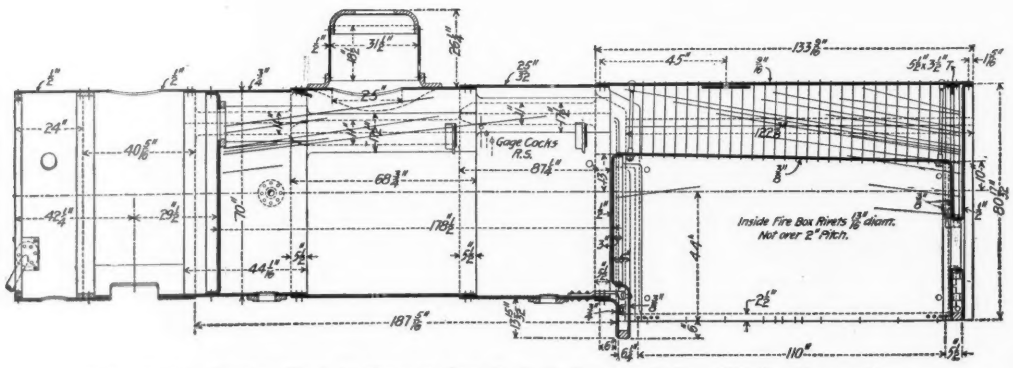
Cross Sections—Extended Wagon-Top, B. & O. Consolidation Locomotive.



Section Through Valve Chamber.



Sectional Elevation of Wide Firebox.



Wide Firebox Boiler—Used on Twenty-four B. & O. Compound Consolidation Locomotives.

NDER COMPOUND CONSOLIDATION LOCOMOTIVE—BALTIMORE & OHIO RAILROAD.

Built at the BALDWIN LOCOMOTIVE WORKS, *Philadelphia, Pa.*

then allowed to remain in the jar for 24 hours before being placed on the wire netting.

Third Test: Oil poured on the waste, completely covering it, and allowed to stand 48 hours without stirring; dope then placed on the screen.

The amount of oil absorbed by the waste in each of these tests was determined by measuring the oil left in the jars when the waste was removed, together with that which drained off from the dope on the screens and subtracting these amounts from the 8 pints originally applied, and was found to be

1st Test: .....4.8 pints of oil = 3.20 pints; 1 lb. waste
2d Test: .....4.9 pints of oil = 3.27 pints; 1 lb. waste
3d Test: .....4.6 pints of oil = 3.07 pints; 1 lb. waste

Similar tests made on the B. & O. R. R., a few years ago, using the waste known as elastic wool waste, composed of 85 per cent. long carpet worsted and 15 per cent. vegetable fiber, and Galena car-oil, showed that 1 lb. waste, thoroughly saturated and drained, held 4.2 pints of oil.

The above tests indicate that the better the quality of the wool waste the greater the amount of oil absorbed, that a more complete absorption is obained when the oil and waste are well stirred than when the waste is merely allowed to soak in the oil, and that 24 hours are sufficient for the preparation of the dope, although 48 hours are prescribed on some roads. An important preliminary to the preparation of the dope is loosening up the dry waste, shaking out the fine shoddy and dirt as far as possible, and removing pieces of wire, sticks, string, leather and other foreign matter which may be present.

An experienced eye can generally determine approximately the relative amount of wool and cotton in a sample of waste under examination, but as it is a general practice to dye jute bright colors and work it in with the wool, its detection is not always easy, and the only accurate method of ascertaining the actual amount of wool present, as well as the dirt and moisture, is by a chemical analysis, made as follows:

A good-sized sample, selected from different parts of the bale, is weighed, dried at 112° F., and then weighed, the loss of weight being the moisture; this dried sample is then washed in gasoline, wrung out, dried, shaken to remove the dry dirt and grit, and weighed again, this difference showing the amount of oil, grease, grit, etc. The sample is then boiled in caustic potash solution, which dissolves out the wool, leaving the cotton, jute and other vegetable fiber as a residue, which is washed, dried and weighed, the loss being the pure wool present. Samples of wool waste used on several roads were obtained a few years ago and analyzed as above, with the following results:

	Wool. Per cent.	Cotton. Per cent.	Dirt, etc. Per cent.
Pennsylvania R. R.	95	1	5
Chicago, Milwaukee & St. Paul.	92	1	7
Union Pacific	85	5	10
Baltimore & Ohio	65	29	9
Philadelphia & Reading	47	39	14
Southern Ry. (a)	44	41	15
Southern Ry. (b)	95	0	5
Norfolk & Western	40	42	18

The above tests were made on the Southern Railway, and as a result the use of the inferior waste (a) was abandoned, and the best grade (b) adopted. The B. & O. sample was elastic packing, containing 15 per cent. elastic fiber and 14 per cent. cotton.

The waste used on the Long Island Railroad contains on the average 75 per cent. wool, 13 per cent. cotton and 12 per cent. moisture and dirt. The figures given above for wool and cotton are the weights when cleaned and dried.

Various substitutes for wool waste are put forward from time to time, among these the following, which were tested in service with unsatisfactory results by the writer —vegetable fiber, scrap-sponge, asbestos and balls of worsted; also several patent "lubricators," the underlying principle in all of them being the feeding up of oil to the journal by iron or brass rollers revolving, through contact with the journal in the oil in the box, and held up by a spring or springs. Excellent results were obtained with some of these mechanical devices, the difficulty being that occasionally one of these would fail at a critical time through some defect, with the resulting hot-box, thus shaking one's confidence in the appliance. It is readily conceivable, however, that something of this kind will some day be invented which may be depended upon under all circumstances, and then the day of waste will be over, and the whole problem of journal lubrication solved in a satisfactory manner, for there are serious drawbacks to the use of waste, and it can not be denied that the use of a reliable mechanical oiler is theoretically preferable.

The best oil and waste obtainable, together with the most perfect mechanical conditions, will not keep the bearings cool, however, if the box is improperly packed. This last point has been very thoroughly discussed recently in several railroad clubs, and the consensus of opinion seems to be that great care should be taken to insure the dope being thoroughly packed at the rear end of the box near the dust-guard so that it remains at all times in contact with the journal and does not settle down and leave that part of the journal without oil; it serves also in that position to reinforce the dust-guard. The forward part of the journal can more readily be seen by the inspector, and its needs supplied. When insufficient, dope is put in the box; through the settling down of the packing the journal is soon left for its entire length without oil, but this rarely happens, for this condition is seen by the inspector at a glance. The greatest danger arises from the use of too much waste, which, when packed in tightly, wipes the oil off the journal instead of feeding it up to it. To avoid this the inspector should lighten up the waste with his packing tool, and if it then appears that there is too much waste, he should at once remove some of it. A neglect of this precaution will cause the surface of the waste to become glazed, forming an impervious coating which will absolutely check the passage of oil to the journal, which soon becomes dry, and then heated.

In the tests described above to determine the amount of oil in a saturated waste it was shown that 1 lb. of the best grade of wool waste will take up and retain about 4 pints of oil. There should, however, be an excess of oil over this amount used at the start in packing a box, and it is better to add this after the box is packed with the drained dope; otherwise there may be a loss of oil in transferring the dope from the bucket to the box. One pint of oil poured in the box after it is packed as above should be sufficient, and none will run out provided the upper level of the dope in the front end of the box is not above the opening.

An examination made of packing removed from the box of a Royal Blue coach, as having reached a condition, in the opinion of the inspector, when it should be replaced with fresh dope containing more oil, showed that this packing contained 2 lbs. wool waste, and 6 pints of oil, or 1 lb. waste to 3 pints oil. From this and the saturation tests described above, confirmed by actual practice, it would appear that safe proportions of waste and oil in a freshly packed box are 1:4, or for a box of average capacity 1½ lbs. of waste and 6 (or at the most 7) pints of oil.

Bearings.—So much has been written about car-bearings recently, and the subject has been so thoroughly investigated during the last decade, that it will be unnecessary to dwell long on this concluding portion of the present article. In 1892 Dr. Dudley published in the Journal of the Franklin Institute, a very exhaustive paper on bearing-metal alloys, giving the results of numerous analyses and service tests made on the Pennsylvania Railroad to determine the relative wear of these alloys, the aim being to adopt as standard an alloy which should hold up the load without distortion or breaking, even when worn thin or used on journals of too small diameter, and at the same time be soft enough to take up the wear readily; thus saving the journals, without wearing so rapidly as to unnecessarily increase the item of brasses in the annual operating expenses.

As a result of this investigation, an alloy designated as E. B. was selected as having made the best record, taking all things into consideration:

	Per cent.
Copper	77
Tin	8
Lead	15

Some doubt was felt, however, as to the wisdom of having so high a percentage of lead, and the P. R. R. afterwards adopted as its standard so-called phosphor-bronze of the following composition:

	Per cent.
Copper	79.7
Tin	10.0
Lead	9.5
Phosphorus	0.8

Other roads soon fell into line, some following the above formula literally, others modifying it somewhat.

The object of adding the phosphorus (in the form of phosphor-tin) is to increase the fluidity of the molten metals, and insure sound castings. This important result is also furthered by the presence of 1 or 2 per cent. of zinc, and with the use of the proper amount of charcoal thrown on the surface of the metal in the crucibles, oxidation can be prevented, and sound castings of uniform, finely granular structure obtained. The presence of zinc not to exceed 2 per cent. of the weight of the bearings is permitted by the specifications of the Long Island Railroad, which are in addition as follows:

	Per cent.
Copper	76 to 78
Tin	9 " 11
Lead	10 " 13

Bearings represented by the sample analyzed are rejected if the per cent. of each metal in the alloy does not come within the upper and lower limits specified.

While a larger amount of zinc is not desirable, on account of its causing the bearing to wear rapidly, it may be of interest to record an exceptional case of a bearing which ran on the Florida Central & Peninsular Railroad until worn very thin, and was then analyzed in the Long Island Railroad laboratory and showed the presence of over 16 per cent. of zinc. The bearing must, however, have been perfect in other respects, and all the other conditions favorable, for some bearings removed on account of hot journals have been found to contain 10 per cent. of zinc or over, and there being no evidence of any other cause of heating, it was in these cases attributed to the presence of the zinc.

The Ajax Metal Co. has recently introduced a bearing containing a large amount of lead, for which great advantages are claimed, supported by figures obtained in abrasive tests, given in a recent number of the *Railroad Gazette*, but a final decision as to the merit of this alloy can only be given after extensive and thorough tests in actual service. The Long Island Railroad Co. is trying a number of these Ajax plastic bearings. An analysis of borings from one of these, made by Mr. C. N. Forrest, the Chemist of this company, showed the following composition:

	Per cent.
Copper	65.26
Tin	5.18
Lead	28.75
Nickel	0.78
	99.97

It would appear that this small amount of nickel was added to enable the alloy to hold this large amount of lead, and to keep it uniformly distributed through the mass of the bearing, for when a large amount of lead is present in a mixture of these metals, it is apt to settle out, as might be expected from its high specific gravity, and as shown by the following experiments made on the Southern Railway:

A large number of bearings, which had never been used, but were scrapped from having become of obsolete pattern, were melted together, without removing the lead lining, in a small cupola furnace, the molten metal run out in ingots, and the lead determined in the first, middle and last portions drawn with these results:

	Per cent.
Lead in first portion	12.00
" " middle "	19.27
" " last "	22.85

Although it is a general practice to line bearings with lead alone, where the loads and service are very heavy it may be preferable to line with a white metal alloy harder than lead, some roads using a Babbitt metal, others a hardened lead consisting of 95 per cent. lead, 4 per cent. antimony and 1 per cent. tin. The latter is the practice of the B. & O. R. R. It is desirable that the bearing surface of the brass should be bored out smooth before the soft lining is sweated in, as it is unusual for a bearing to become heated until the soft lining is worn through, and the journal comes in actual contact with the brass itself; some bearings removed from hot-boxes have been found to have the original rough surface of the castings. To insure the bearings having a smooth surface, as well as the proper radius, they should be inspected before, and not after, they are lined. The Inspector should also break at least one bearing out of every 100 and examine the character and condition of the casting as shown by its fracture. An experienced inspector can determine by his eye, without the aid of lens or microscope, whether the alloy is of uniformly good texture, free from dross, oxidation, etc., although there is no question of the value of the microscopic examination, in which field Messrs. Clammer, Job and Conradson have done valuable work, a paper by Robert Job, Chemist of the Philadelphia & Reading, in the number of the *Railroad Gazette* of June 1 being of special interest.

The responsibility for the prevention of hot-boxes can not be placed on any one official or department, but is divided between the Superintendent of Motive Power, who designs the equipment and must see that it is kept in proper condition, the Purchasing Agent, who buys the oil, waste and bearings, the Inspector, who examines and accepts or rejects them, and the men who pack the boxes and look after them, and it requires the faithful and united efforts of these men to obtain the desired result.

Railroad Accidents in Great Britain in 1899.

The British Board of Trade has issued its return of accidents on the railroads of the United Kingdom for the year ending Dec. 31 last. In train accidents 14 passengers, 19 employees and one other person were killed and 693 passengers, 196 employees and two other persons were injured. The totals, 34 killed and 891 injured, compare with 43 killed and 745 injured during the preceding year. The number of passengers killed in 1898 was 25. The other parts of the report (accidents not connected with train accidents) bring the total number of persons killed and injured on the railroads "in the course of public traffic" up to 1,240 killed and 7,105 injured. The number of passengers killed in other than train accidents was 141; of employees 512 and of other persons 553, which includes 444 trespassers. The present return contains 50 inspectors' reports on particular accidents, an unusually large number.

One of the most notable of these special reports is that of a rear collision on the Cheshire lines, near Manchester, on the morning of Nov. 18, during a dense fog, in which 34 passengers were injured, 14 of the injuries being severe. The line at this point has five tracks, and the signal cabin was on a high bridge above the middle track.

The fog being very dense, a man was stationed at the foot of the cabin stairs to assist the signalman in keeping track of the trains. About 9 o'clock in the morning, a long accommodation passenger train from Liverpool being expected on the track at the extreme north side of the right of way, the signalman asked his helper at the foot of the stairs if "that train had gone past," but the man on the ground says that the question was, "Has that train passed up the new road yet?" The question in this form would refer to a train on the south side of the cabin, and the man on the ground answered "yes." In point o fact the Liverpool train had not passed. The signalman threw his signals to the stop position soon enough to stop this train and then gave permission for another train to follow from the last preceding block station. This second train consisted of two locomotives coupled together, both running backward, and they ran into the passenger train with sufficient force to crush the second and third cars from the rear end. The grade at this point is ascending, but the Liverpool train overran the signal about 100 ft., although warning had been given by the distant signal that it would have to stop at the home signal. In the cabin no train record book was kept, the signalman being very busy, and the inspector recommends that the railroad company employ a boy in the cabin to keep such a record. He also says that the lock and block system, "which is now rapidly coming into use on many of the railroads round London," is well worth the attention of the railroad company.

RAILROAD GAZETTE

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EDITORIAL ANNOUNCEMENTS

CONTRIBUTIONS—Subscribers and others will materially assist us in making our news accurate and complete if they will send us early information of events which take place under their observation, such as changes in railroad officers, organizations and changes of companies in their management, particulars as to the business of the letting, progress and completion of contracts for new works or important improvements of old ones, experiments in the construction of roads and machinery and railroads, and suggestions as to its improvement. Discussion of subjects pertaining to ALL DEPARTMENTS *of railroad business by men practically acquainted with them are especially desired. Officers will oblige us by forwarding early copies of notices of meetings, elections, appointments, and especially annual reports, some notice of all of which will be published.*

ADVERTISEMENTS—We wish it distinctly understood that we will entertain no proposition to publish anything in this journal for pay, EXCEPT IN THE ADVERTISING COLUMNS. *We give in our editorial columns* OUR OWN *opinions, and these only, and in our news columns present only such matter as we consider interesting and important to our readers. Those who wish to recommend their inventions, machinery, supplies, financial schemes, etc., to our readers, can do so fully in our advertising columns, but it is useless to ask us to recommend them editorially either for money or in consideration of advertising patronage.*

The Chicago & Northwestern is now having built at Schenectady some interesting engines for fast passenger service which in several important respects will be different from any now in use, and they will doubtless materially affect future designs of soft coal burning locomotives. In accordance with the latest ideas of firebox design, Mr. Quayle will use grates which are wider than present practice and better suited for burning an inferior quality of bituminous coal. In the adoption of a more rational grate area and better shaped grate for bituminous coal, these passenger engines take rank with Mr. Delano's "Prairie" type engines, which are now being used with good results in fast freight service on the Chicago, Burlington & Quincy. It was the intention to fully illustrate the new Northwestern engines in this issue, but it has been found necessary to defer our publication until the engines are nearer completion. However, many who attend the conventions will probably visit the Schenectady Locomotive Works and have an opportunity to see these engines under construction. It will therefore be of interest to know that 20 by 26-in. cylinders will be used and the drivers, four-coupled, will be 80 in. in diameter and carry a weight of 90,000 lbs. There will be a four-wheel leading truck and a two-wheel trailing truck with outside bearings. The boiler will be of the straight top type with about 3,000 sq. ft. of heating surface and the fire box will be 102 in. long by 65¼ in. wide, giving 46 sq. ft. of grate area.

Russia has compelled Turkey to agree that Russians and Russians only may build railroads in nearly all northern Asia Minor, beginning on the west with the river Sakaria, which empties into the Black Sea about 90 miles west of the Bosphorus, and including all the territory between the Black Sea and a line drawn from the mouth of the Sakaria first southeastward about 150 miles and then nearly due east through Erzerum to the Russian border. This is a comparatively narrow strip of territory, varying from 35 to 130 miles in width and 650 miles long. The Sultan at first attempted to stave off this concession by decreeing a Turkish State railroad in this territory. Russia would not consent to that, and then the Sultan begged for the privilege of having the railroads there under joint Russian and Turkish control; but Russia insisted on its first demand. For some time all the steamer lines touching at Turkish Black Sea ports have been Russian. Not far south of this "sphere of Russian influence," (though "domination" seems a more appropriate term than "influence"), the Germans have a railroad and a concession for its extension, and fears are expressed that these two nations, which seem to be able to keep the peace at home in spite of their long line of common boundary, may have a conflict of interests in Turkey. It must not be assumed that because Russia has secured railroad rights in Turkey that it will soon begin building there. It had rights to build railroads in Persia secured ten years ago, but it built no railroad there, and now it has secured an extension of those rights, and there is again talk of building. It may serve its purpose for some time yet to keep other people out of the territory near its border. The power which controls railroads in this territory will have an enormous advantage in military operations in Asia Minor and Persia, but it is not necessary to own them in order to control them. If they were owned by English or American companies, they would be seized at once, in case of war, by the power able to put troops on them first, and this would be either Russia or Turkey, and probably Russia unless some naval power should take from it the command of the Black Sea, and even then it could invade the interior of Asia Minor from the east by means of the railroad which it is building to Kars. But it might be of considerable advantage to have these Turkish railroads built with the Russian gage.

Roller Side Bearings.

The M. C. B. Committee on side bearings for cars had one of the interesting subjects at the Saratoga meeting. That portion of the report dealing with roller side bearings is especially interesting, although probably the conclusions are incorrect and misleading. This is one of the questions often discussed within the last two years probably because no one really knows much about it, and in the absence of reliable experiments one opinion is about as good as another.

The Committee concludes from tests and from inquiry among different roads that the benefits to be got from roller side bearings do not warrant the additional cost, that the rollers soon become flattened in service and that the best results can only be got by maintaining "a proper clearance" between the present plain side bearings. Now, this is not the opinion of several able men who have had some experience with roller bearings and, further it would have been interesting if the Committee had told how this clearance is to be maintained. It is acknowledged as impracticable with wooden bolsters to maintain clearance at the sides and then we have seen many new cars with metal bolsters which have taken a permanent set after a short time in service. The reason may be, as some bolster makers claim, that roads are unwilling to pay enough to get good bolsters, sufficiently rigid to retain their shape; the fact is that there are many metal bolsters in use which are not strong enough. One Superintendent of Motive Power recently told us that in his opinion the question now is whether to use still heavier and more expensive bolsters in the attempt to carry all the load at the center plates, or use light, cheap bolsters and roller side bearings, which carry a portion of the load. In this way it is thought the additional cost of the roller side bearings will be offset, at the beginning, by the difference in the cost of the two kinds of bolsters and the road with which he is connected proposes to use the cheap bolsters and roller bearings. The Committee's tests would indicate that, so far as the free turning of the truck is concerned, good results can be expected.

The tests referred to were made by dropping a loaded car down a grade, around a curve at the bottom and then along a piece of straight track, the distance the car traveled along this tangent in each case being considered a measure of the effect of the side bearings tested. These tests showed that with the common plain side bearings and a suitable clearance, the car traveled the same distance as when fitted with roller side bearings carrying about half of the weight of the car. With plain side bearings and the load distributed about equally between the side bearings and center plates, the car ran only about half as far along the tangent as in the previous cases.

These tests, while by no means conclusive, seem to indicate that light bolsters with roller side bearings will give about the same freedom of movement to the trucks as might be expected from the use of more expensive bolsters, sufficiently rigid to keep the plain side bearings apart. It may be noted, however, that the conditions of the tests are not those of trains on the road, but correspond more nearly to switching service. Tests made with trains on the road might show that the rolling of the cars assists the trucks with plain bearings to straighten out after passing a curve.

The conclusions of the Committee are misleading in so far as they imply that no changes are required in present practice to maintain a proper clearance between side bearings; and in recommending this clearance the Committee really recommends something apparently impossible to carry out under present conditions.

Resident Ownership of Railroad Stocks.

A few years ago the Illinois Central Railroad Company undertook to make it convenient for subordinate officers and employees to buy the stock of that company. In the annual report for the year ending June 30, 1898, the statement appears that "the number of officers and employees other than directors of the corporation registered as stockholders has increased to 733 and their holdings amount to 2,536 shares," being an average of a little less than 3½ shares for each holder. We have been told lately that since that statement was made there has been little change in the holdings of the company's shares by officers and employees. It appears that when the stock had advanced to above par the rank and file stopped buying. They seemed to think that a share of stock constituted an obligation for $100 and to fail to grasp the fact that it represented a proportionate interest in a commercial venture. This notion appeared to be so firmly fixed that little effort has recently been made to induce the employees to buy the stock. Still, it is a good deal to have 733 shareholders among the employees and minor officers. It is worth something for that number of men to have a solid interest in the prosperity of the property.

The first of May the Great Northern Railway Company issued the prospectus of a plan for getting its employees interested in the property. The Great Northern scheme is designed to enable these investors to share in the prosperity of the company without becoming actual stockholders. To this end the Great Northern Employees' Investment Company, Limited, was formed. This company subscribes for 10,000 shares ($1,000,000) of the stock of the Great Northern at par. It then issues an investment certificate to the employee who wishes to invest. These may be issued in sums as low as $10 each and to any employee other than day laborers who has been for at least three years in the continuous employment of the company and whose yearly wages do not exceed $3,000. No individual can subscribe for an amount greater than $5,000. To the holder of this investment certificate the dividends which may be declared on the stock represented by that certificate will be paid by the Investment Company. In case the subscription is made at some time between dividend payments, interest at 6 per cent. a year on the amount of that subscription will be paid from the date of subscription up to the time of the payment of the next dividend. Furthermore, in case a subscriber wishes to withdraw he will get back the face of his investment and also 6 per cent. on that investment from the time of the last dividend payment to the time of withdrawal. Furthermore, the Investment Company has the right to call in and redeem these certificates, paying the 6 per cent. interest for odd periods. All of the expense of the management of this enterprise is borne by the Great Northern Company on the theory that the benefit which that company will derive from having its employees and minor officers directly interested in the company's prosperity will justify the cost of administering the enterprise. Of course, no dividend is guaranteed, the holder of these investment certificates having to take his chances of profit the same as any stockholder.

It will be noticed that the Employees' Investment Company simply holds the shares in trust for the purpose of receiving dividends and of paying those dividends to the holders of the Investment Company's certificates. These certificates are not assignable or transferable, either absolutely or as security. The holder of the investment certificate is not liable for any assessment on stock or any obligation growing out of stock ownership, and he has no interest in the stock other than the right to share in the dividends earned, declared and paid.

Naturally, a great deal of interest will be felt in the outgrowth of this most commendable enterprise. We should suppose that it would not go very fast, but we should hope that it would go on steadily and that investment in these certificates would increase as the men learn that they are really sound and profitable investments.

There is another feature of railroad stock ownership which is scarcely less important than that of the distribution of the stock among the employees of the company, and that is its distribution among the people who live along the line. In this particular a remarkable change has taken place on the Illinois Central.

In 1867 there were but three stockholders of that company in the State of Illinois, and they held but 157 shares. In the territory served by the company the stock owned was less than one-fifteenth of 1 per cent. of the capital of the company; or the resident holding was $15,700 out of a total of $23,392,900. Six years later, 1873, only 13½ per cent. of the stock was owned

in the United States, and that was owned by 338 holders. Now more shares are held in Illinois than were held in the United States in 1873, and in nearly three times as many names.

The Illinois Central and the Yazoo & Mississippi Valley run trains in 13 States. The first of last March the stockholders in those 13 States numbered 1,350, holding 41,845 shares, or 31 in each name. The holdings in the United States were 58½ per cent. of the total and in Great Britain, 32.43 per cent. There were 5,391 persons who held less than 100 shares each.

The ownership directly along the line of the road is growing constantly and last March nearly 7 per cent. of the total was held in that territory. At that time the holdings in Holland were 7.65 per cent. of the total, but it is now believed that by next September the holdings on the line of the road will be greater than those in Holland.

We have noted these efforts to get railroad stock into the hands of employees, and these interesting facts about changes in local ownership, because both tendencies are of great social and political importance. Nothing could be more wholesome for the railroads or for the communities which they serve. This points to an ideal cure for Socialism as applied to railroads.

Mixed Brakes on Long Trains.

Elsewhere in this issue will be found an elaborate report of an important series of tests of the Westinghouse and the New York air brake apparatus. These tests were made by a member of the permanent editorial staff of the *Railroad Gazette* and were made for our purpose. It seemed to us that it was high time to make such a set of tests and to make the results public. Perhaps it is not a matter of great importance to these two brake companies that such tests should be made, but surely it is a matter of very great importance to the railroad companies. How important it is will appear later in this article. But the New York Air Brake Company has declined now for some years to furnish apparatus for comparative tests by the Master Car Builders' Committee, or under the M. C. B. requirements.

Any discussion of these tests may well be prefaced by a brief reference to notable brake trials in the past, which have had much to do with the development of the air brake. The brakes tried at Burlington in 1886 and 1887 were so slow in action that the shocks at the rear of the train were unbearable. Most of those who were present at the trials believed that electricity would have to be used to actuate the valves in a 50-car train. It was made evident that the main difficulty in applying a continuous brake to a train of such length was to prevent violent shocks, and in our summing up of the matter, after the trials were over, we said that they left practically but three competitors in the field, the Carpenter electro-air brake, the Eames automatic electric vacuum brake and the Westinghouse automatic air brake with electric attachment. Mr. George Westinghouse, however, was no way dismayed and within three months after those trials he had brought out his quick action triple valve and the future of the air brake without electrical attachments was assured.

The importance of getting quick action had become so well-known that in the New York Central tests of Westinghouse and New York brakes at Karner, in 1892 (*Railroad Gazette*, February 24, May 12, 19 and 26, 1893), great care was taken to measure the time of application on the last car of a 50-car train. The Karner tests showed that the New York brakes were inferior to the Westinghouse in quick action as in other respects, and, soon after, a new triple valve was brought out by the New York Air Brake Company.

The next competitive tests of importance were made on the Altoona brake rack by a committee of the Master Car Builders' Association and reported at the 1894 meeting. By that time, the possibility of getting quick action had been pretty clearly demonstrated, and at Altoona, besides testing the quick action features, more attention was given to the action of different triples in graduation and release than ever before. In the Altoona trials, Westinghouse, New York, Boyden, Lansberg and Crane triple valves were used and none fully met the tests which were later embodied in the present M. C. B. code. It is an interesting fact that with the exception of the Westinghouse triple valves, which have since been improved to comply with the M. C. B. requirements, none of the triples used in that test are now being made. The present New York triples, type "C," are radically different from those tested at Altoona, and have never been used in tests, the results of which have been made public up to the time of the recent experiments at St. Louis, given in this issue.

Further, the brake situation is now different from what it was when the Burlington, Karner and Altoona tests were made. Even at the time of the Altoona trials, the larger part of the freight cars of the country remained to be equipped with brakes and the makers of brakes stood to gain much by these experiments, the railroads only wanting to know what was the best brake. Now these conditions are changed, in that practically all freight cars are fitted with air brakes, there is no longer any question as to the best brake and the railroads have the large financial interests at stake. It is now a case of railroads protecting themselves against the introduction of brakes which will interfere with the working of their present equipment. The future business in new brakes will be comparatively so small that the question is much less important to brake makers than at any time in the past, while if a few roads are permitted to apply to freight cars, used in interchange, air brakes which will not work in harmony with the Westinghouse brakes, the majority of roads which have bought the best brakes in the market are going to be the real losers. To-day there are more than 1,000,000 Westinghouse brakes in use, representing an investment on the part of railroads and car-owning companies (including the cost of applying) of about $60,000,000, while undoubtedly there are not 100,000 brakes of all other makes in use. The question is one for the very serious consideration of managing officers.

Before presenting a summary of the St. Louis tests, it may be well to say something about rack brake tests in general. Doubt is sometimes expressed as to the value of rack tests, just as in the case of locomotive laboratory tests, because the conditions only approximate those found in service. With rack tests this is partly due to occasional abuse of this method of testing in the past where the piping and connections were not what they were represented to be. But really there is no reason why rack tests should not give comparative results in some ways superior to road tests. There is one especial advantage in that all the brakes are in view and the action of each can be easily noted.

In the St. Louis tests, New York and Westinghouse triples were used in the same train, the prime object being to determine if, in a train composed mostly of Westinghouse air brake cars, a few New York brakes would affect the working of the other brakes of the train. This is the really important question for the great majority of roads as the small number of New York brakes in use makes it unlikely that there will be many occasions to operate full trains of New York brakes away from home roads. The tests show clearly that the New York brakes do not work in harmony with the Westinghouse brakes and in a number of ways may act to seriously impair the efficiency of the brakes of the entire train.

Those who study these tests carefully will see that the New York triple valve fails to meet the M. C. B. requirements, not because of poor workmanship or from lack of skill in working out the details of the triple; but the failures can be traced directly to fundamental faults of general design in the "C" triples. And in fact the failures shown by the tests have been repeatedly predicted by expert air brake men who formed their opinions entirely from their knowledge of the design.

Those familiar with air brakes will readily see from the service application tests that the brake cylinders and auxiliary reservoirs were the standards of regular service, and also that with all brakes cut in, quick action was got through the mixed train in the time specified by the M. C. B. code. Both kinds of triples passed the graduating tests, the tests of the time to recharge the auxiliary reservoir, and both passed the tests of the sensitiveness of the service and quick action features.

The first failure of New York brakes to meet the M. C. B. requirements is in the emergency application tests. It is required by the M. C. B. code, that from 15 to 20 per cent. higher brake cylinder pressures shall be given after emergency than after full service applications. There is an excellent reason for this requirement as it provides such a working pressure in service that wheels will not be slid. On the other hand, augmented pressure in an emergency application is necessary for stopping in the shortest possible distance. In emergency, the New York triples waste the train-pipe air by venting it directly to the atmosphere, and it therefore follows that with New York brakes no increased brake cylinder pressure can be obtained over that got in full service. On the other hand, the Westinghouse brakes, in emergency, vent train pipe air to the brake cylinders, and give a brake cylinder pressure increased about 20 per cent. and consequently a corresponding decrease in the length of stop just when it is most needed. The accident in 1897 at Garrison's on the New York Central, commented upon at the time (November 19, 1897), was an instance of how this additional braking power of the Westinghouse apparatus may save lives and railroad property in an emergency.

Next, a marked difference is shown between the performance of New York and Westinghouse brakes in getting quick action through to the end of a train, with cars cut out. Cutting out triples is about the only remedy for a defective brake at the disposal of train men; but quick action must be got on trains even with some brakes cut out. With Westinghouse brakes quick action was obtained with the five cars immediately behind the tender cut out. Quick action would jump groups of three cars out in the middle of the train, or ten cars cut out just ahead of the last car of the train. Where New York brakes were tested, two cars were all that could be cut out at the head or middle of the train without destroying quick action. In one test of New York brakes with cars cut out at the rear, quick action was got with nine cars cut out, but by changing triples so as to further remove Westinghouse triples from the gap, quick action could be got through but two cars cut out at the rear, with New York brakes working on either side.

The reason why the Westinghouse triples will give quick action through more cars cut out at the rear than in the middle of the train seems to be on account of the train pipe having a dead end at the rear. It seems reasonable to suppose that when the cut-out cars are in the middle of the train, the effect of the train pipe reduction made by the triple, just ahead of the gap, is lessened by having a large volume of air in the train pipe beyond that triple. When the cars cut out are at the rear of the train there is a smaller volume in the train pipe at the rear of the last working triple, and it may well be that an emergency action at that point will result in a more effective lowering of train pipe pressure than if the same action took place at the middle of the train.

The brakes tested at Altoona in 1893 showed that not more than three cars could be cut out at the front end without destroying quick action, and in most cases no more than two could be cut out. Evidently the Westinghouse triples have been improved since that time to give the results obtained at St. Louis, while the New York brakes are lacking in this respect and in service might cause the quick action to be destroyed by cutting out a small number of cars.

The New York brakes failed entirely to meet the M. C. B. requirement that triples must give quick action if a service application, resulting in 20 lbs. pressure in the first brake cylinder, is followed immediately by a full emergency reduction; and, further, even when a slight service application was made, resulting in 5 lbs. pressure in the first brake cylinder, quick action could not be obtained. This is a very serious fault especially where the two kinds of brakes are used together. The point seems well established by the tests that anything which will cause the New York triples to move slightly in the direction of the service position will result in a failure of the quick action feature if an emergency reduction immediately follows. The effects of an attempt to use the emergency directly after a slight service reduction, or when from some other cause the triples have assumed the service position, depend upon the location of the New York brakes in a train of mixed brakes. If the New York brakes are on the first few cars there will be a failure to get quick action throughout the train, resulting in a long stop. If there is a group of New York triples in the middle of the train, quick action will be got on the forward part ahead of the New York brakes and the severity of the shock at the rear will depend upon the speed and length of the train. This condition would produce more severe shocks than in the first Burlington brake tests where plain triples were used. In those tests the shocks at the rear were so great as to warrant the M. C. B. committee in refusing to sanction the use of air brakes on freight trains.

It will be seen from the record of the St. Louis tests that the New York triples when used on the rack corresponding to a full train of freight cars, often acted in an erratic manner. That is, a triple would act badly and later on would work normally, which in service might cause many brakes to be cut out, for which no apparent reason would be found when the cars were later inspected at terminals. The sticking open of the vent valve of the New York triple after an emergency application was not uncommon. This prevents the release of any of the brakes on the train until the valve is closed or the brake cut out. At other times erratic working was plainly due to the increased friction of the triple pistons,

there being two pistons in the New York where one is used in the Westinghouse valve. In addition, one piston of the New York triple must have a very close fitting packing ring, or the quick action feature is seriously impaired if not rendered entirely inoperative. It may also be said that in all there are 31 parts in the New York as compared to 21 parts in the Westinghouse triple, and the New York valve has one-third more working parts than the Westinghouse. The two kinds of valves have no parts in common and in no sense can they be considered interchangeable. The effects of leaks past the check valves of New York triples are shown by the miscellaneous tests, and will be of interest to those familiar with air brake work.

In conclusion, the St. Louis tests, in general, confirm what expert air brake men have predicted as to the working of New York and Westinghouse brakes in the same train and repeat on the rack what has often happened on the road. The New York brakes fail to give greater brake cylinder pressures in emergency than in full service applications, quick action is not obtained with cars cut out as required by the M. C. B. code and there is an entire failure to give quick action if for any reason the New York triples have first moved slightly toward the service position. Beside these things, New York triples appear to be erratic in their working. These faults are of such a nature as to impair the efficiency of all the brakes on the train and are caused, not by poor workmanship or lack of care in working out details, but by inherent defects in the design of the New York "C" triples. Further, it is evident that these defects cannot be effectually remedied or they would have been corrected before now.

A knowledge of these things is of the first importance to roads which have large numbers of Westinghouse brakes. The facts stated would justify any action those roads might take to control the interchange of cars fitted with brakes which will not work in harmony with their present equipment. This might be merely for the sake of protecting their own trains, but a further incentive is offered by a decision of the New York Supreme Court. That Court has held that it is not alone sufficient to supply cars with brakes but the public safety requires that the brakes should be the best in use. Here then is an opportunity which a lawyer could use to advantage in damage suits brought against railroads. The moral is plain.

The state of Massachusetts is trying to regulate interstate commerce. The Legislature is considering a bill approving the lease of the Boston & Albany to the New York Central, in which one of the conditions is that the Central must promise never to charge higher rates on export freight to Boston than it charges to New York. Such a provision, enacted into law, would, no doubt, arouse strong protest from New York city interests, and it certainly does seem to be repugnant to the spirit of the constitutional provision that states must not interfere with the action of Congress in regard to interstate rates; but we are not sure but the arrangement will work, if the Central agrees to it. It requires nothing more than the railroads are now doing voluntarily, though the distance to Boston is 60 miles greater. The Interstate Commerce Commission might some time decide that the rate to New York ought to be lower than that to Boston, but it is difficult to see how it could prevent the road from following each New York reduction with a reduction to Boston. Members of the commission have advocated a law to prevent a railroad from reducing rates, but no one has yet pointed out how such a statute could be enforced. If New York city should seriously suffer, however, and be able to clearly prove her case, it would be competent, we should think, for the Federal courts to declare the contract between the state and the road void, as being contrary to public policy, and it is to be observed that in such a case the court would be apt to give the benefit of the doubt, if doubt existed, to the advocate of unrestrained competition, which would be New York. It is curious to see how the Massachusetts Legislature lays emphasis on the export trade. Besides the rate proviso, the proposed law requires the expenditure by the road of $2,500,000 on the East Boston branch, the line over which the export freight is carried 11 miles from the main line to the steamship wharf. It is desired that this money be spent partly for eliminating grade crossings on the branch, and the expenditure may be spread over a period of 10 years. Beyond this the committee seem to have no very definite idea of what they want, except that they want to make sure that the New York Central shall derive no profit out of the Massachusetts road. The city of Boston seems to be the ruling power in the Legislature. If conditions were to be imposed on the lessee as the price of approval of the lease, one would suppose that a limitation on local rates in the state at large would be one of the first things thought of, but the fear of the "country members" does not seem to be so potent at Boston as at Albany and some other capitals. One member from the western part of the state did offer an amendment requiring a reduction of passenger fares to 2 cents a mile, but it does not appear to have been acted on as yet.

NEW PUBLICATIONS.

The Steam Engine Indicator. By Cecil H. Peabody, Professor of Marine Engineering and Naval Architecture, Massachusetts Institute of Technology, 12mo., 153 pages, 98 figures, index. New York: John Wiley & Sons, 1900. $1.50.

Prof. Peabody starts out with neither preface nor introduction and apparently he assumes that no apology is necessary for another book on the indicator. This, in itself, is commendable; but he starts also without a table of contents, which, we take it, is not a matter of well considered principle, but mere carelessness, and at least it is inconvenient.

The first 40 pages of this little volume are descriptive of indicators and their attachments. This description is followed by 30 pages on methods of using the indicator and 20 pages on planimeters and their uses, and some 50 pages tell of those facts which may be learned from the use of the indicator and analysis of the diagrams. We do not discover that the author had in mind any new or unusual experiences, facts or deductions, but that he has aimed simply to make a compact, convenient and simple treatise on the subject which he has taken up, and in this we judge he has succeeded.

Massachusetts Railroad Commission.—The Annual Report of the Board of Railroad Commissioners of Massachusetts, which was noticed in the *Railroad Gazette* of March 2 and 16, is now issued in complete form. Besides the usual railroad map the volume also contains a map engraved specially to show the electric railroads of the State, of which there are 1,846 miles. These lines are shown in red; and all the rest of the map, including the steam railroads, is in thin black lines.

TRADE CATALOGUES.

Journal Boxes.—McCord & Co. have issued a small pamphlet entitled, "An Object Lesson in Journal Boxes," which shows the advantage of using malleable iron for journal boxes, instead of ordinary gray iron. Several views are given of a Lake Shore car having malleable boxes, one of which was badly bent in a collision. However, the damaged box and lid were quickly hammered into shape, so that the car could be hauled to the repair tracks; the sills, also, being broken. The point is made that had this car been fitted with cast-iron boxes, they would have been broken and that the actual cost of repairs would have been $2.18. The malleable iron box and lid in this case cost 20 cents to repair.

Machine Tools.—The Pond Machine Tool Co., of Plainfield, N. J., (also 136 Liberty St., New York; 25 Victoria St., London, and other cities), sends us a little book designed to advertise its wares at the Paris Exposition. It is a volume of 94 pages, very prettily printed and bound, being the work of Bartlett & Co., of New York. It is printed in English, French and German. The cover is ornamental boards in gilt and two delicate shades of green, with conventional ornaments, and it looks like a volume of quotations from the poets or a Kipling birthday book. We should hardly recommend the student to undertake to form his French and German literary style on the text of this volume, the French and German having been created by the simple process of converting the English words into French or German, as the case may be. The idiom therefore sounds a little queer, and the printer has frequently shown a certain American contempt for accented letters. Nevertheless, the benighted foreigner who wishes to know about the product of this concern will have no trouble in getting at the author's meaning—the book, like the firm, being designed primarily to "get there."

Bethlehem Steel.—The Bethlehem Steel Co. has recently issued a little pamphlet "intended to briefly illustrate and describe the successive steps in the manufacture of armor plate, ordnance and forgings." General views are given of the works of the company and of mines and docks in Cuba. Special views are given also of blast furnaces, steel furnaces and various processes, but some of the most impressive pictures are those showing the colossal ingots and forgings that are made, as, for instance, one nickel steel ingot for a gun weighs 222,300 lbs. The length of the ingot, including sink head, is 16 ft. 7 in. and diameter 6 ft. 2 in. An ingot for a nickel steel armor plate weighs 273,500 lbs. There are views showing various stages in the manufacture of armor plate and of testing it, also in the manufacture of ordnance from the ingots to the gun finished and mounted. A remarkable forging is a four-throw nickel steel crank shaft for the torpedo boat destroyer Farragut. This is forged in one piece, the cylindrical portions being hollow. The total length is 12 ft. 8½ in. and the diameter 6¾ in. A hollow forged shaft for a 7,500 h. p. engine for the Metropolitan Street Railway Co., New York, is shown, being one of 11 similar fluid compressed, open-hearth steel shafts forged hollow on a mandril. This shaft is 27 ft. 4 in. long, 37 in. in diam. on the fly-wheel fit and 16 in. in diam. of axial hole. The weight is 70,000 lbs.

Baldwin Locomotive Works Exhibit at Paris.—The Baldwin Works send us a pamphlet of 35 pages designed for the Paris Exposition. This opens with a very short account of the Works and their capacity, and then gives weights, dimensions and engravings of the two engines shown at Paris by the Baldwin Works. These are an 8-wheel compound for the French State Railroads and a mogul simple for the Great Northern of England. These engines were built in the regular course of business for the companies which have bought them and therefore show standard construction adopted by those roads. When released from the Fair they will be put in service by the companies by whose courtesy and co-operation they are shown. The pamphlet also describes material shown by the Standard Steel Works, namely, steel-tired wheels, steel tires, axles, wrist pins, crossheads, siderods and main rods. A brief of the company's specification for steel tires is given.

Conference of Western Presidents.

The second quarterly conference of the presidents, directors and other officers of the principal roads west, northwest and southwest of Chicago was held in New York City June 8 and 9. The following systems were represented by executive officers: Alton; Atchison; Burlington; Chicago Great Western; Chicago & Northwestern; Chicago, Milwaukee & St. Paul; Chicago, Rock Island & Pacific; Chicago, St. Paul, Minneapolis & Omaha; Illinois Central; Missouri Pacific; Rio Grande Western; St. Louis Southwestern; Soo Line; St. Louis & San Francisco; Southern Pacific; Union Pacific; Wisconsin Central and Wabash. Mr. E. T. Jeffery was again unanimously elected chairman. There were a number of perplexing questions before the conference, and while no differences of opinion existed, it was found impossible to settle the matters under discussion until after consultation with interested lines not represented, and an adjournment was taken to Chicago, where the conference will reconvene June 19.

Four local committees were formed. These committees are: Kansas City, S. M. Felton, Chicago & Alton, chairman; Omaha and Sioux City, A. C. Bird, Chicago, Milwaukee & St. Paul, chairman; St. Louis, B. F. Yoakum, St. Louis & San Francisco, chairman; St. Paul and Minneapolis, J. T. Clark, Chicago, St. Paul, Minneapolis & Omaha, chairman.

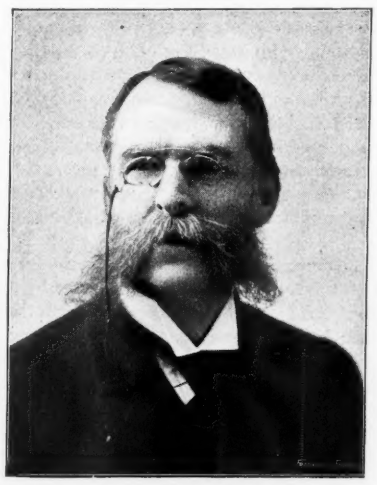
James Henry Smart.

BY W. F. M. GOSS.

James Henry Smart, for 17 years President of Purdue University, died at his home in Lafayette, February 21, 1900.

His whole life was given to educational work. Beginning as a teacher in a New Hampshire country school, he became in turn, principal of the Toledo High School, Superintendent of Schools for the City of Fort Wayne, State Superintendent of Public Instruction for Indiana, and, finally, President of Purdue, a position whose requirements never ceased to challenge his ambition.

While always concerned with problems of the school, his interests reached far out into the business world. He enjoyed association with those engaged in pursuits far removed from his own. Under his leadership, men meeting by chance during a day's journey on a railroad train, were invariably formed into an experience meeting, in the



James Henry Smart.

course of which each one was led to tell something of the work he was doing, and of the things which interested him. Activity always excited his respect and attention, and he delighted in men who were "doing things." His vigorous nature was quick to respond in full sympathy to the experience of others. He was able to assume their difficulties, rejoicing in their achievements as though they were his own.

Four years ago, at the close of a hard year of routine work, he indulged himself with a few days' attendance upon the Master Mechanic's Convention at Saratoga. When called upon to speak, he explained his presence in the convention by saying, "I have learned in the later years of my life that if the president of a college buries himself in a library with his books, studying the thoughts of men who are dead, he will not be able to manage the boys who live to-day. So I came here to mix with men who are living and dealing with live subjects, for the purpose of learning how best to do my business." In these few words lies the secret of much of his success.

During his stay in Saratoga he missed no session of the convention. Discussions which probably would have been tedious to most college presidents, for example, the

one on driving-box wedges, excited his admiration, which he expressed by exclaiming, "There are no small things! Every question is large when men have the ability to see." Again, when in the discussion of the report on the apprentice boy, one speaker after another gave emphasis to his desire to deal with boys of good morals, placing character above every other consideration, the discussion to him became a sermon, and he could not refrain from expressing the wish that all his professors might have been there to hear it.

When President Smart came to Purdue in 1883, he found an institution consisting of a few poorly equipped buildings. The income was small, there were debts which had necessarily been left over by the previous administration, and the State Legislature, then but recently adjourned, had flatly refused to give any aid. A hostile and inharmonious faculty added to the difficulties of the situation. Under his leadership, Purdue has gained an assured income six times greater than that which it possessed when he came, and new buildings and laboratories which, in their extent and uniquie character, are fitting monuments to his untiring efforts. He has left a faculty embracing five times as many persons as were numbered by the faculty which received him, and an organization which, all through his long illness and for the months that have elapsed since his death, has run so smoothly that no matter of routine suffers through his absence.

With the advent of Dr. Smart into college life, some of the well-established theories were given a severe shaking up. Professors who explained the failure of students to finish a subject by saying, "I give the work; if the students do not care to profit by the instruction, it is no affair of mine," were soon made to feel that at Purdue, at least, instructors would be held responsible for the success of their classes, and that the standing of their students was regarded as an important element in determining their value to the University.

The slender resources of the University, especially in the earlier years of President Smart's administration, demanded the greatest possible care in expenditure. The old process of dividing available funds among the several departments ceased. The President authorized each outlay of money and audited every bill. Money for improvements was spent in accord with a fixed plan of development. Members of the faculty desiring to extend their facilities or enlarge their work, made their applications in person to the President. He gave all a patient hearing, but reserved the right of deciding upon the urgency of the claim. The professor who asked for a hundred dollars for the general needs of his department and who had nothing else to say, never got the hundred dollars. It was required that he first make his request specific. If he presented a plan which was poorly developed or involved unnecessary work, a few well-directed questions exposed its weak points, and the proposer would go away satisfied that he had failed. On the other hand, one who could make plans, present reasons, and estimate costs, was sure that the President would be an attentive listener. He was quick to apprehend the importance of a problem and to appreciate its bearing upon kindred interests. He would often warm to the arguments of a professor and supplement them by considerations of his own, and even when he might not be able to render the assistance which was asked, the instructor felt that he could depend upon the sympathy of his chief.

When making improvements, it was a principle with President Smart to give emphasis to a few things at a time, and having developed these, to pass on to others. He did not believe in weakening his effort by a too great division of his strength. In connection with the development of some laboratory, it often happened that a choice would arise between the purchase of some large and expensive piece of apparatus and the purchase of a number of smaller pieces. In such cases, President Smart invariably chose the larger and more important thing, his theory being that such a piece of apparatus became a nucleus around which the smaller and less expensive elements would sooner or later assemble.

A good illustration of this is to be seen in his attitude toward the question of establishing a laboratory for locomotive testing. That the president of a university should respond to the suggestion of a department concerning an undertaking which involved the expenditure of a considerable amount of money, and, in the absence of favorable advice, and even in the face of some adverse criticism, give it his approval and support, was a proposition which demanded careful study. Many men skilled in business or in engineering pursuits and well acquainted with the conditions surrounding locomotive service, when applied to for advice were apathetic or gave responses that were discouraging, and, excepting a single company of locomotive builders, no one looked upon the scheme with favor. But President Smart carefully considered every favorable plea and weighed every objection, and when he finally decided to enter upon a line of work so new and untried as that of laboratory tests of locomotives, he took a bold but, nevertheless, a well-considered step. And he afterward contributed so much of his spirit of enthusiasm to the Board of Trustees as led them, out of the limited resources at their disposal, to supply means for executing his plans. Later still, when difficulties appeared in the development of mechanical matters, he was ever patient with delays, helpful in advice, and unfailing in his support. Although the engineer may have done much in the establishment of Purdue's locomotive testing plant, it was President Smart who assumed the weightier responsibilities, and to whom is due in a large measure the credit for whatever good has thus far been accomplished and whatever promise there may be for the future.

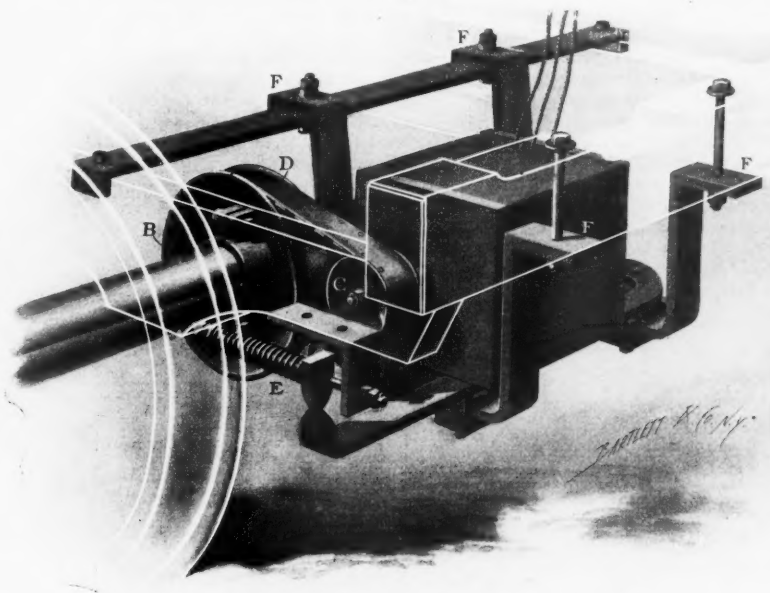
President Smart's pluck and courage were unfailing. On one occasion before the income of Purdue had been made certain, division in the Legislature resulted in a failure to pass the general appropriation bill, and compelled the Purdue authorities to face a two-years' period under reduced income. The situation was at best disheartening and a feeling of apathy quickly extended to faculty and students, some of whom entered into a correspondence with other institutions with the expectation of an early withdrawing from Purdue. In this emergency Purdue's president without the least doubt as to the future of the institution, assumed all responsibility, made plans for enlarging the scope of work, furnished money on personal credit, and ordered new apparatus and supplies. A large dynamo was delivered to the Electrical Laboratory, and a 300,000-lb. testing machine stood on a car addressed to the Applied Mechanics' Laboratory, and the word went round that more was on the way. With men all about busy in building foundations and erecting machines, students and professors alike concluded that the institution had not yet died, and that perhaps they had better not hasten their departure. The result was that under wise management, financial arrangements were entered into which permitted work to be advanced and broadened during what had promised to be a period of retrenchment.

Again, when the great fire came to Purdue, destroying its recently completed Engineering Laboratory with an equipment which had been installed at the expense of years of toil, the President did not waver. While the ruins were still smoking, he appeared on the chapel platform with the assurance that the building should be reared again, that its tower should go at least one brick higher than before, and that its equipment should be more complete than that which had been destroyed, pledges so well fulfilled that a part of the reconstructed building was ready for occupancy within six months after the fire, and the entire structure rededicated in less than two years.

It is hardly necessary to say that this is not an attempt to review Dr. Smart's life or work, but only the setting down of a few points which illustrate his method of work, especially in its connection with the engineering departments of the institution, where his best effort was spent. His energy and enthusiasm, his clearness of vision, his knowledge of men, and his faith in them, make his life worthy of attention from all who labor to achieve results. And his sympathy with the living questions which appeal to the engineer, is the warrant for introducing this sketch into that issue of the *Railroad Gazette* which will go to those great mechanical conventions in which he was so much interested.

The Axle Light Apparatus of the Consolidated Company.

The engraving shows the electric lighting apparatus driven from the axle as now built by the Consolidated Railway Electric Lighting & Equipment Co., of New York, which has absorbed several of the axle lighting companies. It will be observed that the faces of the driving pulley on the axle (*B*) and the armature pulley (C) are V-shaped, and that the driving belt is provided with cleats which run in these grooves. The armature pulley is covered with leather. This the company calls a "flex-



New Axle-Light Apparatus of the Consolidated Company.

ible frictional gearing." This, it is claimed, gives the elasticity and flexibility of the belt drive with the positive motion of a spur gearing.

We are not informed that any other important change has been made since we last described this apparatus. The dynamo, of course, is in the case marked A in the engraving and E is a tension spring.

The dynamo maintains a pressure of from 32 to 40 volts and is automatically switched in when the speed of the train is 15 miles an hour, and the current to the lamps is uniform at all speeds. When the car is at rest the lights are supplied at 30 volts by storage batteries, and the lamps are prevented from receiving more than 30 volts by resistance in their circuit. The filament of the lamps is short and not affected by vibration.

There is automatic control governing the connection of the dynamo to the storage battery and lamp circuit. By automatic control also the current remains normal at high speeds. This is accomplished by the use of a small motor that operates when the dynamo is generating, and throws resistance in and out of the field coils.

Oiling is done automatically, and it is said that an equipment can be used for three or four months without attention to the oiling apparatus.

I.—Railroad Concrete Masonry.

BY W. A. ROGERS, M. AM. SOC. C. E.*

The necessity of practicing the strictest economy has led engineers of Western railroads to seek carefully methods and materials which lessen the cost of constructing and maintaining the structures and roadbeds of these lines. The bridges and culverts were originally built largely of timber, and, as a rule, only the very largest bridges were of iron. As these lines have become more important, the temporary structures have been renewed with more permanent ones of iron, steel and masonry, but until within the last few years, in this reconstruction with permanent work, stone masonry has almost invariably been used; brick has occasionally taken its place in arch and other culvert work. The use of stone in the various forms of masonry has had many drawbacks, among which are the difficulty of getting a good, durable stone within a reasonable distance of the work, the practical necessity of using derricks for setting stone of the larger dimensions with the incident obstruction of traffic while the boom is swung across the track, the difficulty of finding the necessary skilled labor during certain times, notably when building trades are active, thus making the expansion of the masonry force difficult, and last, but not least, the greater cost, especially of first-class stone masonry. In addition to these disadvantages accompanying the use of stone masonry, the increasing difficulty of procuring suitable timber and piles for wooden bridges emphasized the desirability of renewing each year as much as possible of the temporary work with permanent structures.

These conditions have led railroad engineers to the study of concrete as a form of masonry for railroad structures as it seemed to possess many advantages over stone as a form of masonry, provided it had the quality of durability, and its use in footings has been the growing practice for a number of years. From this small start, its use, first in unimportant structures such as small culverts and low bridge abutments, has increased until it has been adopted for all classes of ordinary bridge and culvert construction by a number of the important lines of the Middle West. Concrete construction is yet in its infancy and its qualities are necessarily imperfectly understood and practice differs materially in minor details. Mistakes will undoubtedly be made on account of a misconception of characteristics, but as these are better known errors will be fewer. In the following, the qualities of this material will be described as the writer understands them, and the practice followed in work with which he has been connected will be given.

Composition and Characteristics.

Cement.—Concrete as generally used is made of cement, sand or gravel and broken stone in varying proportions, mixed in various ways. It may be divided into two general classes, that in which natural cement is used and that in which Portland cement is used. The quality of the finished product depends first on the quality of the materials used and then on the thoroughness of the mixing. In the choice of cements great care should be exercised. In the writer's opinion, cements of known reliable qualities should be chosen and then each shipment tested to discover any change in qualities due to change in manufacture. By the use of certain brands an intimate acquaintance with the qualities of these brands is obtained.

As a general principle, the writer believes that a natural cement specification should require that the neat tensile strength shall equal 80 lbs. per sq. in. at the age of

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7 days and 150 lbs. per sq. in. at the age of 28 days, that it shall be sound and shall be ground to a certain degree of fineness and that each test shall conform closely with the average determined by previous tests.

The Portland cements should reach a certain neat tensile strength at the ages of 7 and 28 days; this requirement should be moderate in the writer's opinion, being say not over 400 to 450 lbs. per sq. in. for the 28-day test, and say not over 300 lbs. per sq. in. for 7 days. The cement should be sound as determined by the pat test, and it should be finely ground. For ordinary concrete work it should not take its intial and final sets before 1½ and 4 hours respectively. And last but not least in importance the tests of each shipment of each brand should agree closely with the average results of previous tests of the same brand, and non-conformity should be ground for rejection notwithstanding the fact that the cement may have passed all other tests satisfactorily.

Some of the reasons why it is a good plan to stick to brands of known good qualities are that: It is difficult, if not impossible, to determine the qualities of a cement by the ordinary short time tests which may be made by the railroad engineer. Seven-day tests are affected so materially by temperature, the amount of water used in mixing, etc., that they are more or less unreliable. In the course of the work it is frequently necessary to use the cement even before the ordinary short time tests are made, and if known brands are used little risk is run. The rejection of a shipment of cement is almost invariably followed by loss to the user due to delays in replacing it and consequent delay to the work. Another advantage in adhering to certain brands is that from long continued use an intimate acquaintance with their action under varying conditions is gained.

Sand and Gravel.—The choice of the sand or gravel to be used is fixed largely by the material to be found on the line of the railroad. Certain qualities are generally considered requisite for that used in the manufacture of a first-class concrete. The sand should be coarse and sharp with grains of varying sizes and a small proportion of voids. The use of gravel in place of sand has proved very successful in the experience of the writer. In its use, the percentage of sand in it is determined and the amount of gravel and stone in proportion to the cement is fixed accordingly. The sand and gravel should be fairly clean. Specifications generally call for them to be free from all dirt or other foreign material; authorities differ, however, as to this requirement.

Compressive tests of concrete cubes show that gravel when used to replace sand as stated above gives as great strength as the sand mixture. A small amount of dirt in the sand is probably not seriously objectionable if the sand or gravel is suitable in other ways. During the past season a pit containing a very desirable gravel, except for this one particular, was located in the vicinity of a bridge at which we were building eight concrete piers. The dirt in the gravel had the appearance of containing a large amount of iron and was in considerable quantity, amounting probably to 10 per cent. of the volume; unfortunately this was not ascertained exactly. A good gravel could not be obtained on the line without a haul of nearly 200 miles, and it was therefore very desirable to use this, at least in the footings, if it could be done in safety. In order to determine this, tensile tests were made of mortar composed of the sand sifted from this gravel mixed with Portland cement, also compressive tests of concrete cubes using this gravel were made. These tests were compared with tensile and compressive tests of briquetts and cubes made at the same time with the same Portland cement mixed with a clean first-class sand and gravel. The tests seem to show a peculiar state of affairs and an abstract of the results is given below. The dirty gravel is described as Jackson Pit gravel No. 1 and No. 2, No. 2 having more dirt than No. 1. In the tensile tests the clean sand is described as Hammond pit and in the cube tests as Wabasha pit sand.

Comparative Tests of the Tensile Strength of Clean and Dirty Sand.

Name of Sand.	Proportions.	Tensile St'ngth, Lbs. per Sq. In. 1 day	7 dys	28 dys	3 mos	Remarks.
Hammond pit....	1 pt. Portland cement to 1 pt. sand.	95	490	511	457	Hammond pit sand i a first-class clean, coarse sand.
Jackson pit, No. 1		86	464	607	627	
" " " 2		170	501	573	515	
Hammond pit....	1 pt. Portland cement to 2 pts. sand.	79	329	393	402	Jackson pit sands are both fair sands, except very dirty. The No. 2 is dirtier than No 1.
Jackson pit, No. 1		62	377	448	541	
" " " 2		84	402	525	514	
Hammond pit....	1 pt Portland cement to 3 pts. sand.	59	179	274	349	
Jackson pit, No. 1		39	256	339	43	
" " " 2		69	348	396	398	

It will be seen in the case of the tensile tests that the two samples of dirty sand gave a higher tensile strength for all proportions at all ages than the clean sand except at "one day" and "seven days." In the compressive tests of the concrete cubes it will be seen that in the case of the proportions of 1 part of cement to 2 parts of gravel to 5 parts of broken stone the clean gravel gave a strength of 158,000 lbs., while the average strength of the two samples of dirty gravel was about 144,500 lbs., only a little less than the clean, while in the case of the proportions of 1 part cement to 2½ parts of gravel to 5 parts of broken stone the clean gravel gave a strength of 120,600 lbs., and the dirty 133,700 lbs., or about the same difference in the favor of the dirty gravel that there was in the other instance in favor of the clean. The results of these tests were such that we used the dirty gravel in mixing the concrete for the footings.

A series of tests is now under way in which mortar made of various proportions of cement and sand is being tested in tension and compression. The sand is first taken clean and then proportions of loam from 2 per cent. to 20 per cent. are added. These tests will cover several years. In any case, the question whether sand or gravel shall be used, and also, within certain limits, what qualities shall be required is dependent largely on what may be found within a reasonable haul on the line of the railroad making the improvement.

Comparative Tests of the Compressive Strength of 12-in. Concrete Cubes made of Clean and Dirty Gravel. Broken at the Age of 28 Days.

Name of Gravel.	Proportions. Portland cement.	Gravel.	Crushed stone.	Compressive strength, lbs.	Remarks.
Wabasha pit	1 pt.	2 pts.	5 pts	158,040	Wabasha pit gravel is a good, clean gravel. The Jackson pit gravels are the same class as the sands in above table.
Jackson pit, No. 1				142,230	
" " " 2				146,780	
Wabasha pit.....	1 pt.	2½ pts	5 pts	120,610	
Jackson pit, No. 1				133,680	

Crushed Stone.—The crushed stone question is also settled largely in the same way, within certain limits as to quality. To get the best results crushed stone should consist of fragments not exceeding 2 in. or 2½ in. in greatest dimension and the individual pieces should vary in size from grains the size of coarse sand to the maximum. They should be hard, angular and sharp, of such a nature that the sides are not "glassy" and should be free from dirt. Where the stone is hard it may be taken as it comes from the crusher without screening. Pebbles or round stones may be used in place of crushed stone if desired but with a loss of strength, which may be due to the fact that with the round pebbles there is a greater percentage of voids or because the adhesion of the mortar to the smooth sides of the rounded pebbles is less than to the rougher sides of the broken stone. Whether the round stone should be used in preference to the broken stone, where either may be obtained, is largely to be determined by cost and strength desired. Where Portland cement is used it is as a rule far the most expensive ingredient, per unit of volume, in the manufacture of the concrete and in order to get the same strength with the rounded stones as may be obtained with the angular broken stone it will be necessary to increase the amount of cement probably more than enough to make up the difference in the cost of the stone. In the vicinity of Chicago a very good quality of this rounded stone may be obtained, under the name of washed gravel, composed of the pebbles and small stones left after washing the sand from gravel found near that city. It consists of pebbles ranging in size from that of a hazel nut to 2 in. in diameter.

Tests to determine the comparative value of a hard crushed limestone, a soft crushed limestone, and this washed gravel when used in the manufacture of concrete were made with the results shown in the table.

The gravel used in the above tests was composed of about 2-3 coarse sharp sand and 1-3 pebbles from the size of sand to 1½ in. in diameter. It will be seen from the tests that the hard limestone concrete gave an average strength of about 183,000 lbs., the softer limestone an average strength of about 168,500 lbs., and the washed gravel an average strength of about 151,000 lbs. for the proportions of 1 part of Portland cement to 3 parts of gravel to 4½ parts of stone. The test of the softer stone alone, compared with the same mixed with the washed gravel in equal proportions, strengthened the belief in the superiority of the soft limestone over the round pebbles of which the washed gravel is composed. It is not always possible to have the best crushed stone or other material within a reasonable haul of the point of use, and it then becomes necessary to make the best use possible of the material at hand.

Strength and Cost.—The strength and cost of concrete is dependent within certain limits on the proportions of the ingredients. As before said the cement is usually much the most expensive of the ingredients per cubic foot. In general terms, that arrangement of proportions which gives the desired strength of concrete with the use of the least amount of cement is the most economical for the work under consideration. In the case of natural cement concretes made of cement sold in the markets of the Middle West, the price of which is only from 4 to 5 times the cost of broken stone per unit of volume, the strength developed within the short period of time during which it may usually be permitted to set before loading is comparatively low. The proportions of materials are therefore usually fixed for the greatest strength obtainable and without regard to the amount of cement required. A preliminary series of tests to determine if possible the proper proportions to be used in mixing concrete with the materials we had was made in 1898. The tests were on 12 in. cubes at the age of 28 days, this age having been used largely in the concrete tests of the writer because it is frequently necessary to load structures built of concrete at that age. The materials other than the cement used in making the concrete for the cubes were the same gravel described previously, composed of about 2-3 sand and 1-3 pebbles and a hard crusher run limestone. The proportions used in the Portland cement concrete tests varied from 1 part of cement, 1 part of gravel, 1 part of broken stone, to 1 part of cement, 4 parts of gravel, 4 parts of broken stone. Two brands of cement were used in this test and the tests of the two brands were made under different conditions, so that their results may not be compared. The proportions used in the natural cement concrete tests varied from 1 part of cement, 1 part of gravel, to 1 part of cement, 3 parts of gravel, 6 parts of broken stone. Two brands of cement were used in this test also, and as the tests were made under different conditions the results of the two brands may not be compared. The results are given in the tables.

Comparative Tests of Compressive Strength of 12-in. Concrete Cubes made with Different Crushed Stone.

No. of Cubes Broken.	Proportions. Port and cement.	Gravel.	Stone.	Average Compressive Strength at 28 Days, Lbs.
3	1 part.	3 parts.	4½ parts hard crusher-run limesto e..	183,180
3	1 part.	3 parts.	4½ parts soft screened lim stone.....	168,580
3	1 part	3 parts.	4½ parts washed gravel.....	150,890
3	1 part.	4 parts.	7 parts soft screened limestone.....	103,000
3	1 part.	4 parts.	{3½ parts soft screened limestone.... {3½ parts washed gravel.....	92,430

The results seemed to indicate in the case of the natural cements that given a certain proportion of cement and gravel, the addition of the crushed stone to this mixture would not affect the strength materially until a certain amount had been added, which coincided closely with the point where the voids in the stone exceeded the volume of the mortar, after which the strength decreased materially on the addition of more stone. The strength was not affected materially; it was not decreased but, if anything, was increased by the addition of stone up to the point mentioned. Also the tests indicated that the strength of natural cement concrete was dependent primarily on the proportion of cement to sand decreasing with each added part of sand.

The tests of Portland cement concrete cubes gave the

EFFECT OF VARYING PROPORTIONS OF GRAVEL AND CRUSHED STONE. NATURAL CEMENT CONCRETE.

No. of Cubes Broken.	Proportions. Cement.	Gravel.	Crushed Stone.	Average Compressive Strength in Lbs. at 28 Days	Remarks.
2	1 Milwaukee.....	1	..	62,650	Failed gradually by splitting and flaking in line of strain.
1	"	1	1	77,450	" " " " " " "
1	"	1	2	71,650	" " " " " " "
1	"	1	3	78,040	" " " " " " "
1	"	2	..	35,925	" " " " " " "
1	"	2	2	42,850	" " " " " " "
1	"	2	3	41,400	" " " " " " "
1	"	2	3½	35,690	" " " " " " "
1	"	2	4	33,880	" " " " " " "
1	"	2	5	29,575	" " " " " " "
1	"	3	..	31,150	" " " " " " "
1	"	3	3	29,000	" " " " " " "
1	"	3	4	29,450	" " " " " " "
1	"	3	5	15,825	" " " " " " "
1	"	3	6	16,050	Disintegrated.
1	Louisville.....	2	2	34,600	Failed gradually by flaking in line of strain.
1	"	2	3	37,850	" " " " "
1	"	2	4	35,300	" " " " "
1	"	2	5	25,575	" " " " "
1	"	2½	3	29,400	" " " " "
1	"	2½	4	30,490	" " " " "
1	"	2½	5	24,750	" " " " "
1	"	3	3	25,625	" " " " "
1	"	3	4	23,300	" " " " "
1	"	3	5	15,800	" " " " "

same results with regard to the amount of stone used with a given sand and cement mixture, but gave a different result with regard to the strength of varying sand and cement proportions. The results of strength obtained showed little if any change in the compressive strength of the different mixtures until after so much gravel had been added that the voids in it were in excess of the amount of cement used when the strength decreased rapidly, seeming to indicate that there was little advantage, as far as strength was concerned, in using a mixture in which the cement was much in excess of the voids in the sand or gravel, or the sand and cement mortar in excess of the voids in the stone.

EFFECT OF VARYING PROPORTIONS OF GRAVEL AND CRUSHED STONE. PORTLAND CEMENT CONCRETE.

No. of Cubes Broken.	Proportions. Cement.	Gravel.	Crushed Stone.	Average Compressive Strength in Lbs. at 28 Days	Remarks.
2	1 Alpha	1	1	178,600	Failed gradually by splitting and cracking in line of strain.
2	1 "	1	2	200,000	" " " " " "
2	1 "	2	2	194,675	" one cube unbroken at 200,000 lbs.
2	1 "	2	3	200,000	" gradually by splitting in line of strain.
2	1 "	2	4	200,000	" " " " " "
2	1 "	2	5	175,800	" " " " " "
2	1 "	3	3	190,325	" " " " " "
2	1 "	3	4	197,175	" " " " " "
2	1 "	3	5	195,000	" " " " " "
2	1 "	4	4	141,500	" " " " " "
2	1 Atlas	2½	3	185,000	Unbroken at 185,000 lbs.
1	1 "	2½	4	178,100	Failed gradually by flaking and cracking in line of strain.
2	1 "	2½	5	151,750	" " " " " "
2	1 "	3	3	181,450	" " one cube unbroken at 185,000 lbs.
2	1 "	3	4	159,925	" " by flaking and cracking in line of strain.
2	1 "	3	5	170,700	" " " " " " "
2	1 "	3	6	119,850	" " " " " " "
2	1 "	3½	4	185,000	" " one cube unbroken at 185,000 lbs.
2	1 "	3½	5	178,700	" " " "
2	1 "	3½	6	185,000	Unbroken at 185,000 lbs.

In the writer's practice gravel is substituted for sand wherever it can be obtained conveniently and the proportions used are then about 1 part of natural cement to 2 parts gravel to 3½ parts of broken stone; and 1 part Portland cement to 3 parts of gravel to 4½ parts broken stone, and 1 part Portland cement to 4 parts gravel to 7 parts broken stone. Where gravel is used he finds that frequently a little more broken stone can be added. With these proportions the cement required per cubic yard of concrete as shown by averages taken from a large volume of work is about as follows:

For natural cement concrete (1:1 ½:4).....1.5 barrels.
" Portland " " (1:2:5) .....1.2 "
" " " " (1:3:7 ½) .....0.9 "

With the gravel described, about 0.8 cu. yds. of broken stone and 0.5 cu. yds. of gravel are required per cubic yard of concrete of any of the proportions given.

(To be continued.)

Making Suspension Bridge Cables.

At the last regular meeting of the Engineers' Club, of Cincinnati, Mr. J. H. Hilton, Chief Engineer of the Brackett Bridge Co., gave a description of the making and erection of the steel wire cables for a suspension bridge over the Ohio River between Rochester and Monaca, Pa., about 20 miles below Pittsburgh. The main span of the bridge is 800 ft. long between towers; the back span on the Monaca side being 400 ft. long from the tower to the anchorage, and the back span on the Rochester side 400 ft. long to a steel bent supporting the cable and one end of a truss span, at the same elevation as the anchorage on the Monaca side, and from the bent to the anchorage about 260 ft., making the total length between anchorages about 1865 ft., and the cables about 1900 ft. long. The cables are composed of seven strands each, each strand have 288 wires and being about 2½ in. in diameter, making the finished diameter about 7 in.

The strands for the cables were made on the ground, which happened to be a level street leading to the bridge. Before beginning the work of making the strands a single wire was put in the position on the towers which the cables would occupy in the structure, and allowed to take its natural position. Points were marked on this wire for the ends and where it crossed the towers, after which it was hauled back and used as a guide wire by which the length of all others was obtained. Suitable supports were placed in the ground at intervals of about 50 ft., on which the strands rested during construction. Each strand virtually consisted of a single wire, the wire being drawn off the drums on which it was wound and looped over a pin at either end, the required tension being secured by a tension space where the wires each sagged the proper amount.

An erection cable was placed in position a short distance above the location for the cables, resting on temporary wooden supports placed on top of the permanent steel towers, and the strands drawn over into place, suspended from trolleys running on the erection cable, and connected to the anchorage pins at each end. When the strands were all in position and the binding wires removed the individual wires fell into place quite accurately, after which the cables were wrapped around with wire in the usual manner by a special machine designed and furnished by the company that rolled the wire.

The New York, Ontario & Western Consolidation Engines.

In our issue of March 23 last we described the 99-ton consolidation freight engine recently built by the Cooke Locomotive & Machine Co. for the New York, Ontario & Western, from designs by Mr. Geo. W. West, Superintendent of Motive Power of that road.

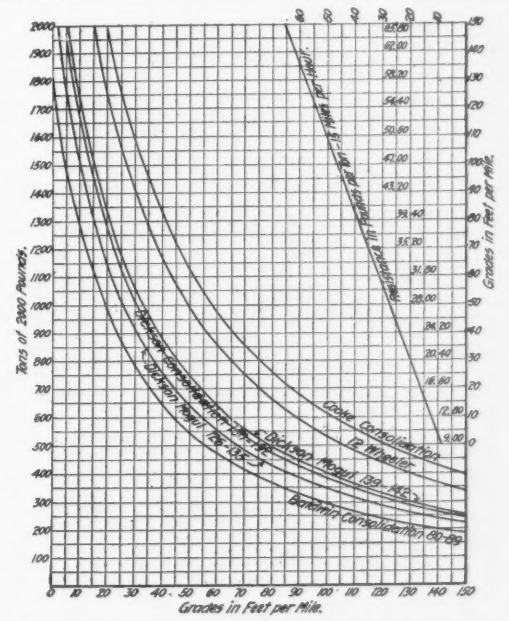
Four other engines, alike in all respects to the one which has been running for more than two months, have been ordered. These five will do the work now done by eight 66-ton engines on the main line. The eight will be transferred so as to do the work of 10 lighter consolidation engines burning soft coal, making a saving of two, so that five engines less will be required to run the freight trains on the road.

The new consolidated engines have 177,200 lbs. on the drivers, 20,930 lbs. on the forward truck, making a total of 198,130 lbs., about nine-tenths of the weight of which, it will be noted, is on the driving wheels. The cylinders are 21 in. by 32 in., and the working steam pressure is 200 lbs. The total heating surface is 3,289 sq. ft., and the gate area is 87.4 sq. ft.

Through the courtesy of Mr. J. E. Childs, General Manager of the road, we have obtained information which enables us to make a study of the hauling capacity of the new engines, as compared with certain other locomotives, and also to add a table giving some particulars about recent consolidation engines.

The curves in the accompanying diagram give the estimated hauling power of five engines run on the road and of a 12-wheeler not used on the N. Y., O. & W. The total weight of the selected engine is 201,000 lbs., which is about the same as the Cooke consolidation, but the weight on the forward wheels of the latter is about half as much as on the forward truck of the foreign 12-wheeler. The cylinders have the same dimensions in both. The curves were all plotted for the same general conditions for each engine, as noted below the engraving.

The two upper curves are of particular interest, inasmuch as they are for engines of nearly the same weight, the same cylinder diameter, and alike in many other particulars, but with a difference of about 18,000 lbs. on the drivers. On a 70-ft. grade, the O. & W. engine should, by the diagram, haul 850 tons, while the 12-wheeler can not theoretically haul over 750 tons, at 15 miles an hour. This calculation falls short of actual tractive power, the basis of estimate being only 20 per cent. of weight on drivers. By the commonly accepted formula for efficiency the consolidation engine should pull 975 tons up the grade given, at 15 to 20 miles per hour, under most favorable conditions. The facts later stated bear out the calculation well. It has been found that the O. & W. engine can do better than this, as shown by careful records for March. On March 27, a train of 55 cars weighing 4,077,686 lbs., was hauled up a 70-ft. grade by the consolidation engine aided by two pushing engines weighing 66 tons each. It was known that these two engines could not do more than haul their rated capacity of



Estimated Hauling Power of Certain Freight Engines.

Baldwin Consolidation, 20 x 24 in., wt. on drivers, 88,000 lbs.
Dickson Mogul, 19 x 24 " " " " 103,000 "
" Consolidation, 20 x 24 " " " " 114,000 "
" Mogul, 19 x 24 " " " " 119,000 "
Selected 12-wheeler, 21 x 32 " " " " 159,000 "
Cooke Consolidation, 21 x 32 " " " " 177,200 "

Note: The curves are plotted from estimated capacities and do not include the weight of the engine. They were all figured for a tractive force of the engine equal to 20 per cent. of the weight on the drivers.

WEIGHTS OF CERTAIN RECENT CONSOLIDATION AND 12-WHEEL ENGINES.

Road.	Class.	Engine.	Firebox	Cylinders.	Weight on Drivers.	Weight on Forward Truck, Lbs.	Weight of Engine, Lbs.	Weight of Tender, Loaded, Lbs.	Maker.	Published in the *Railroad Gazette.*
S. P. of Cal.	12-Wheeler	Compound	Narrow	23 in. and 35 in. x 32 in.	155,000	37,000	192,000	97,150	Schenectady	Jan. 6, 1899.
L. V. R. R.	Consolidation	"	Wide	18 in. and 30 in. x 30 in.	202,200	22,900	225,100	120,900	Baldwin	Jan. 13, 1899.
N. P. Ry.	"	"	Narrow	23 in. and 34 in. x 34 in.	169,000	20,200	189,200	106,863	Schenectady	Jan 27, 1899.
O. R. & N. Co.	"	Simple	"	19 in. x 30 in.	136,200	17,800	154,000	98,000	Brooks	Feb. 3, 1899
C., C., C. & St. L.	"	"	"	22 in. x 30 in.	165,000	20,000	185,000	110,000	Richmond	April 28, 1899
L. S. & M. S.	"	"	"	20½ in x 28 in.	138,500	18,000	156,500	93,900	Brooks	May 19, 1899.
So. Pac.	"	Compound	"	23 in. and 35 in. x 34 in.	173,000	20,000	193,000	89,500	Schenectady	May 5, 1899.
C. R. R. of N. J.	12 Wheeler	"	Wide	21 in. x 32 in.	159,000	42,000	201,000	*	Brooks	.....
A., T. & S. Fe.	Consolidation	"	Narrow	21 in. x 28 in.	144,500	17,000	161,500	90,000	Baldwin	.....
" "	"	Tandem Comp.	"	15 in. and 25 in. x 28 in.	151,500	22,500	174,000	90,000	A., T. & S. F.	June 16, 1899.
D. & H.	"	Simple	Wootten for Slack Anthracite	20 in. x 26 in.	122,600	17,400	140,000	*	Dickson	Nov. 18, 1898.
B. R. & P.	12-Wheeler	"	Narrow	21 in x 26 in.	140,500	31,500	172,000	90,000	Brooks	Sept. 24, 1897.
O. A. & P. S. R. R.	Consolidation	Compound	"	15½ in. and 26 in. x 30 in.	165,000	19,500	184,500	103,500	Baldwin	.....
B. & O.	"	Simple	"	22 in. x 28 in.	156,000	16,000	172,000	94,000	"	.....
B. & O. S. W.	"	"	"	21 in. x 28 in.	138 000	15,000	153,000	96,000	"	.....
"	"	Compound	"	15½ in. and 26 in. x 28 in.	145,500	17,500	163,000	96,000	"	.....
E. J. & E.	"	Simple	"	21 in. x 26 in.	147,000	13,500	160,500	92,500	"	.....
Iowa Central	"	"	"	21 in. x 26 in.	140,000	14,000	154,000	98,000	"	.....
"	"	Compound	"	15 in. and 25 in x 26 in.	140,000	16,000	156,000	98,000	"	.....
C. St. P. & M. & O.	"	Simple	"	22 in. x 28 in.	156,275	14,150	170,425	82,575	"	.....
Southern	"	"	"	21 in. x 28 in.	133,000	19,000	152,000	85,000	"	.....
Union R. R.	"	"	"	23 in. x 32 in.	208,000	22,000	230,000	104,000	Pittsburgh	Oct. 28, 1898.
Penna. R. R.	H—5 "	"	"	23½ in. x 28 in.	177,000	21,000	198,000	104,600	Penna. R. R	July 14, 1899.
Gt. Northern	12-Wheeler	"	"	21 in x 34 in.	172,000	40,750	212,750	96,000	Brooks	Jan 7, 1898.
N. P. Ry.	"	Compound	"	23 in. and 34 in. x 30 in.	150,000	36,000	186,000	*	Schenectady	Feb. 26, 1897.
Penna. R. R.	H-6 Standard Consolidation	Simple	"	22 in. x 28 in.	166,400	20,100	186,500	111,900	Penna. R. R	July 14, 1899.
P. B & L. E.	Consolidation	"	"	23 in. x 32 in.	208,000	26,000	234,000	100,000	Pittsburgh	.....
D., L. & W.	"	"	Wide	22 in. x 30 in.	175,500	22,150	197,650	101,000	D., L. & W.	Aug. 25, 1899.
I. C. R. R.	"	"	Narrow	23 in. x 30 in.	196,000	20,000	216,000	....	Rogers	Dec. 15, 1899.
I. C. R. R.	"	"	"	23 in. x 30 in.	193,200	39,000	232,200	....	Brooks	Sept. 29, 1899.
N. Y., O. & W.	"	"	Wide	21 in. x 32 in.	177,200	20,930	198,130	100,000	Cooke	March 23, 1900.

*Not given; probably 90,000 to 100,000 lbs.

530 tons each. As the total weight of the train was 2,038 tons, the consolidation locomotive hauled 978 tons. While this may be regarded as a selected run, not showing what the engine is doing daily, other records for daily runs show results which approach this haul. This comparison is important only as showing the advantage in having as much weight as possible on the drivers.

Although weighing 50 per cent. more than the 66-ton engines, the new Cooke locomotives consume but 32 per cent. more coal for the same run.

In the accompanying table are given the weights of certain recent consolidation and 12-wheel engines. This is not a complete record, but contains most of the recent very heavy engines.

TECHNICAL.

Manufacturing and Business.

About six months ago we described the Powers regulator for automatically controlling the temperature of coaches and sleepers. Since that time the Empire State Express, Boston & Albany trains, between New York and Boston, as well as trains and cars on several other Eastern roads, have been equipped with this device. The Powers Company have also equipped a number of trains on prominent roads in the West. They will make an exhibit at the conventions in Saratoga.

Thomas G. Grier, who, for a number of years, was with the Western Electric Co., has opened an office at 200 Monroe St., Chicago, Ill., and represents the Nungesser Electric Battery Co., Wirt Electric Co. and Dicke Tool Co. The Nungesser dry battery is now being introduced on railroads to operate block signals, crossing alarms and other purposes requiring a primary battery. It is made in two forms, one for open circuit and one for closed circuit work.

S. A. Crone has resigned from the Gold Car Heating Co. to become general sales agent of the Spiral Nut Lock Co., of New York City. Mr. Crone will also act as eastern representative of the Brown-Lilly Co., of Indianapolis, and has a patented dust guard of his own invention which he will shortly place on the market.

The American Steel Foundry Co., of St. Louis, is prepared to execute orders for steel cars from 120,000 lbs. capacity down. These include plain gondolas, gondolas with drop bottom, side dump gondolas, self-clearing twin hopper cars, etc.

Arthur B. Johnson, appointed Chief Inspector a few months since for the Pressed Steel Car Co., at McKee's Rocks, Pa., was, on May 25, promoted to the position of General Foreman of the Steel Yard, Shearing Department and Pressing Departments. Mr. Johnson entered the service of the Pullman Company as draftsman at St. Louis, and was later transferred to Chicago. From Chicago he went to New Haven, Conn., and was draftsman in charge at the shops in that city until he entered the service of the Pennsylvania Railroad as draftsman at Altoona, where he spent five years.

The Ajax Metal Co. tell us that their foundry has never been as busy as at present. They are running double force and are behind in orders. They are receiving large orders daily for the Ajax plastic bronze.

The car works of the John Stephenson Co., at Elizabeth, N. J., were sold at auction on June 12, the total sum realized being $400,000. The principal buyers were Joseph C. Willetts and Adolph Wimpfheimer, of New York, who represented the banks interested.

The New York, Ontario & Western will offer at public auction at its freight station at Sidney, N. Y., on June 30, 86 carloads of ties. The ties include 7,000 of sawed oak, 7 ft. long, 6 in. face and 5 in. thick, and 15,000 of hewed chestnut, 7 ft. long, 5 in. to 7½ in. face and 5 in. thick. The ties were for an electric road, and appear to have been taken for freight charges.

New York, Chicago & St. Louis Railroad Bridges.

The Eighteen-Mile Creek viaduct, at Idlewild, N. Y., will be renewed jointly by the Western New York & Pennsylvania and the New York, Chicago & St. Louis. It is to be a double-track steel viaduct, 688.5 ft. long, and about 100 ft. high. The old masonry will be used, with the exception of one channel pier. The New York, Chicago & St. Louis will renew the viaduct at Girard, Pa., over Elk Creek. It is a single-track structure, 1,470 ft. long and about 100 ft. high. The Conneaut viaduct, at Conneaut, O., is also contracted for. It is 1,320 ft. long and 60 ft. high. At Willoughby, O., the company is building a 720-ft. viaduct. All are made up of plate girder spans, varying in length from 30 ft. to 100 ft. The company has also under construction single-span plate girder bridges at Blue Creek, near Hedges, O., and at Eel River, near South Whilly, Ind. They are 65 and 80 ft., respectively. The King Bridge Co., of Cleveland, has the contract for the entire tonnage of the steel in the structures. These improvements are to be paid from the $190,000 appropriated for improvements this year.

Iron and Steel.

The Buenos Ayres & Pacific Ry., of Buenos Ayres, Argentine Republic, has placed an order in the United States market for 12,000 tons of rails.

A director of the Pennsylvania Steel Co. is reported as stating that the capital stock may be increased. The company booked orders for 25,000 tons of rails last month from Mexico, Canada and India.

Work on removing the old Kinzua viaduct by the Erie Railroad, near Bradford, Pa., preparatory to building a new bridge, was started several weeks ago.

Pittsburgh dispatches state that the Valley Bessemer Association has decided to reduce the price of pig iron from July 1. It is announced from Birmingham, Ala., that the price in that market for iron has dropped to $16 per ton for No. 1 foundry, $15.50 for No. 2 and $14.75 for No. 3. A further decline is anticipated.

The Delaware, Lackawanna & Western Railroad has contracted for about 10,000 tons of steel to replace 35 or 40 bridges this year.

Frederick Moore, Chief Engineer of the Milwaukee Bridge & Iron Works, Milwaukee, Wis., has resigned and is now manager of the Modern Structural Steel Co., of Waukesha, Wis.

It is announced that the main office of the American Bridge Co. will be at 100 Broadway, New York. W. H. McCord, formerly of Post & McCord, New York, has been appointed Vice-President in charge of structural steel for office buildings, armories and other large structures. Chas. Macdonald, Vice-President, is in charge of railroad bridge building. Frank Conger, Vice-President, is in charge of road and highway bridges, and Chas. M. Jarvis, Vice-President, has charge of the 28 constituent companies. C. C. Schneider, as heretofore noted, is Vice-President in charge of the Engineering Department, and the executive officers are: Percival Roberts, Jr., President; J. A. Hatfield, Assistant President; W. H. Connell, Treasurer; Charles C. Price, Auditor, and Douglas O. Morgan, Secretary.

The Sharon Ore Steel Co. has let a contract to Drake & Stratton Co., of Philadelphia, for stripping their ore property at Virginia, Minn. The contract price is $150,000.

The Southwest Iron, Coal & Coke Co. has been organized in Cincinnati, O., with a capital stock of $5,000,000. The incorporators are J. W. St. Clair, of West Virginia; J. Harry Wood, of Virginia; G. W. Sheen, of Tennessee; W. J. Overbeck, of Cincinnati, O.; O. F. Clifford, of Baltimore, and William Hooper, of New York. The new company is the consolidation of the Tennessee Iron Co. and the West Virginia Coal, Coke & Lumber Co.

Volatile Substitutes for Boiler Water.

At the centennial anniversary of the Royal Technical High School, Charlottenburg, Germany, Prof. E. Josse, Chief of the Mechanical Laboratory, reported experiments in increasing efficiency of steam engines. The investigation followed lines laid down by Mr. G. Behrend and Dr. Zimmerman, who obtained patents upon a chemical process in 1899. The principle is the old one of causing the exhaust from a steam engine to vaporize a liquid having a lower boiling point than water. For the purpose, sulphurous acid was used. The exhaust from a two-cylinder compound stationary engine was led through a vaporizer containing the acid. The gas generated from the acid was made to run a small independent engine. The acid-gas exhaust was condensed in an ordinary surface condenser and forced back into the vaporizer by a pump. Thus it is re-expanded and re-used indefinitely. The result as reported is an increase of 56 per cent. efficiency on a well-designed compound steam engine. The experiments were conducted upon a small scale. The condensing and vaporizing surfaces are necessarily very large proportionately. While the gain is apparently large there are considerations of pumping and deterioration from acid that render the net result commercially doubtful. The experiment is not without value, but would perhaps be most fitly classed with liquid air operations and other wonder-working, the practical values of which are still held in abeyance.

International Tramways Exhibition.

An exhibition of tramways and light railroads will be held in London at the Royal Agricultural Hall, Islington, from June 23 to July 4, inclusive. The purpose of this exhibition is to bring together every kind of apparatus designed for tramways and light railroads, covering permanent way, power houses, rolling stock, car equipment, brakes, etc. In the list of exhibitors we find a number of American houses, as, for instance, the Brill Company, the British Westinghouse, the Consolidated Car Heating Company and the New York Car Wheel Works.

Motor Trucks for France.

The Western Railroad of France will try electricity as a motive power on a suburban line from Paris to Versailles. The motor trucks will be furnished by the McGuire Manufacturing Co., Chicago, and will be similar to those used on the Brooklyn Elevated. The side frames of the trucks for France will be of solid steel with spiral springs over the journal boxes and a combination of spiral and elliptic springs beneath the bolster; the bolster and its springs being suspended from the transom by heavy links as in the Pullman trucks. Two G. E. 55 motors of 150 h. p. each will be used on each truck, which, complete, will weigh about 21,000 lbs. The wheel base is only 6 ft. and these trucks will require no more room than those commonly used in street car service.

Compressed Air Cars in New York.

President Vreeland has said, when asked about the statement concerning the abandonment of the use of air power by that company: "Our experience in providing underground electric traction for the Fifty-ninth and Twenty-third Streets cross-town lines demonstrated that the removal and replacement of the pipe obstructions along the avenues was so costly as to render underground cross-town building almost prohibitive, and we are, in consequence, making extensive experiments with traction systems which will obviate this great outlay, as, for instance, on the Twenty-eighth and Twenty-ninth Streets line, with compressed air, and on the Thirty-fourth Street line, where we are preparing to test the storage battery system. We are equipping Twenty-eighth and Twenty-ninth Streets with new heavy rails and are awaiting an entire new equipment of cars with a different type of motor from those now in use, in which all the defects experimentally developed in the first lot are eliminated. These cars will be delivered within a few weeks. It is our settled policy to test every known means of traction that promises improved public service and economy in operation. Tests of this kind can not be made in a few weeks."

The Pintsch Lighting System.

At the close of each year, the Julius Pintsch Co., of Berlin makes a report showing the cars equipped with the Pintsch system of gas lighting, also the buoys for harbor and channel lighting, and the gas works erected. The Pintsch system of lighting for cars and buoys is now used in twenty-one countries, and the figures for the year ending Dec. 31, 1899, are printed below. The constant extension of this system is evidenced by the number of cars equipped in the year 1899, namely, 7,292. The new locomotive equipments furnished in 1899 were 367. These are used almost exclusively in Europe, and in fact all but 31 were for European roads, the 31 being supplied to railroads in Brazil. The total number of cars now equipped with Pintsch gas throughout the world foot up 98,182. These figures, as before stated, were up to Dec. 31, 1899, and it is safe to say that there are now throughout these 21 countries over 100,000 cars so equipped. The total number of locomotives now figure up to 4,021; gas works, 306; buoys and beacons, 1,038.

Cars, Locomotives and Buoys Lit With Pintsch Gas, Dec 31, 1899.

	Cars.	motives. Loco-	Works. Gas	Buoys
Germany	36,305	3,784	71	98
Denmark	45	...	3	21
England	18,290	18	87	236
France	5,425	...	22	238
Holland	3,168	114	9	60
Italy	1,528	...	4	15
Switzerland	380	9	1	...
Austria	3,211	...	10	1
Russia	2,275	57	13	13
Sweden	475	8	4	2
Servia	154	...	...	..
Bulgaria	33	...	1	..
Turkey	103	...	...	...
Egypt	2	...	3	112
Canada	49	...	2	46
Brazil	974	31	1	31
Argentine	1,041	...	10	2
Chili	46	...	1	...
India	7,744	...	10	...
Australia	2,053	...	3	29
United States	14,883	...	51	134
Total	98,182	4,021	306	1,038
Increase for year...	7,292	367	3	146

The Ferguson Locomotive Kindler.

One of the new devices to be shown at the Saratoga conventions is the Ferguson fire kindler, which, a short time ago, was put on the market by Messrs. Leach & Simpson, Chicago. Several railroads are now using this kindler, and those who have only heard of the device will be interested in seeing it work. The flame is applied beneath the grates and the fire door is kept closed, the time required to start a fire varying from 25 to 45 minutes. The apparatus consists of a tank holding 25 gallons of oil, a hose coupling to connect with the compressed air main, a hose terminating in a nozzle for spraying the mixed oil and air, and a valve for controlling the relative proportions of oil and air. The tank is mounted on a truck that can easily be moved from one part of the roundhouse to another. The valve controlling the oil and air is the principal feature, the proportions of the mixture being varied by the movement of a handle. Turned one way, air alone passes through and oil adhering to the inside of the hose is removed. The nozzle is at the end of a long tube and this is thrust into the ash pan and the flame passes up through the fuel until it is wholly ignited. The fire door being closed prevents the admission of cold air and causes the draft to pass up through the fuel. This is held to be superior to the old method of blowing through the fire door and allowing the flame to strike the sheets.

Chicago Track Elevation.

The Pennsylvania ordinance proposing raising 13 miles of track in Chicago, Ill., at an expense of about $6,000,000, has been recommitted to the Committee on Track Elevation by the City Council.

The Manhattan Elevated.

At a meeting of the Executive Committee of the Manhattan Railway Co., held Tuesday of this week, several contracts were approved which practically complete the machinery contracts for the central power station, and it was said that trains will probably be running by electricity by the 1st of next February. It was decided to adopt in principle the plan of running six-car trains, with a motor at each end, each car to have four motors. Contracts were authorized for two electric stairways, one at Fifty-ninth St. and Third Ave. and one at Twenty-third St. and Sixth Ave. The powerhouse machinery will begin to arrive in September.

Gas Engines in Blast-Furnaces.

The successful use of blast-furnace gases to drive blowing engines is assured. The trial of a 600 h. p. gas engine at Seraing, Belgium, is said to have given high efficiency. Gas is used without purification, as taken from the blast-furnace. The engineers who conducted tests assert that their earlier surmise of efficiency of five times that of burning the gas under boilers for steam-engine blowing, is fully borne out. At the Seraing furnaces the output of pig iron is from 150 to 160 tons per 24 hours. The blast is forced entirely by gas engine, pressure of 12 lbs. per sq. in. being obtainable, when desired, revolutions at

that pressure being 62 per minute. It is intended to build some 1,200 h. p. engines, capable of blowing at 25 to 30 lbs. pressure. Drawings for these engines have been made and orders received for three of the engines, to be used in furnaces in Lorraine. The 600 h. p. engine has been running since November 20, 1899.

Knitted Padding.

The Knitted Mattress Co., of Canton Junction, Mass., maker of knitted padding for upholstering car seats and backs, is now making a specialty of furnishing its material for cab and caboose cushions and mattresses for sleeping cars. For these purposes the padding is woven 3 in. thick. The company also supplies lighter weights for table padding for dining cars.

Ballast and Ties.

The American Railway Engineering and Maintenance of Way Association is sending out two blank forms designed to get information for the use of the committees on ballast and ties. These forms are so prepared as to collect information on the kind of ballast or of tie used, its cost and its history in track. The ballast circular deals with stone, gravel, burnt clay, slag, cinder and burnt shale, chatts, earth, rock screenings and chert as possible materials for ballast. It takes up also the questions of dust prevention, of loading, transportation, handling, etc.

The tie circular is designed to ascertain the number of ties in track and ratio of renewal, the traffic over that track as to frequency and weight, the weight of rail, the cost of treated and untreated ties and the costs of renewal.

Obviously, careful answers to the questions submitted by the committees will give material for some very useful reports. The headquarters of this Association are at Room 1562 Monadnock Block, Chicago, and any railroad officer who is interested in these subjects and who has not received the circulars, can procure them by writing to the Association.

THE SCRAP HEAP.

Traffic Notes.

The Manhattan (Elevated) Railway, New York City, now advertises express trains on the Second Ave. line from Hanover Sq. (Wall St.) northward to Willis Ave., just beyond the Harlem River, in 22 minutes. The distance is about nine miles. It appears that there is one such train daily.

Mr. J. F. Goddard, acting as arbitrator between the Erie and the Pennsylvania, has decided that the fare from Akron, O., to New York should be $1.50 less over the Erie than over the Pennsylvania Lines. When the Pennsylvania acquired control of the C., A. & C. it reduced the fare from Akron to New York, wiping out this differential. The Erie complained at this, and its complaint is now justified by the arbitrator.

The rate on corn by lake from Chicago to Buffalo has lately risen from 1.25 cents a bushel to 2 cents, there having been some scarcity of vessels, due, it is said, to the withdrawal of a number of vessels from service by the Rockefeller Line. The withdrawal of these vessels, which had been assigned to carry ore, has tended to keep Lake Superior rates from falling, and this has affected Chicago. It is said that the railroads are taking grain from Chicago to New York at about 10 cents per 100 pounds, which is only a very little higher than the lake and rail rate, when to the latter is added the cost of marine insurance. It is said that provisions for export are being carried from Chicago to the Atlantic seaboard at very low secret rates.

Freight Rate Discrimination in Kentucky.

The Kentucky Court of Appeals has reversed the decision of the lower court by which the Louisville & Nashville was, a few months ago, declared guilty of unjust discrimination in freight rates. There were a number of suits, all of which were begun in Marion county, and the charge was violation of the law of the State forbidding discrimination. The majority of the court holds that where the railroad company ships wheat to a mill and flour from the mill, it is not a discrimination to charge the mill owner a less rate to haul his fuel than other people in the same town, and that it is not a violation of the constitutional section which prohibits discrimination in rates. A dissenting opinion, by Judges Paynter, Guffy and White, holds that if it is not a discrimination to ship fuel for a less rate under the circumstances in this case, then the constitutional section is invalid for the purposes it was intended.

Japanese Railroads in Korea.

In the last Japanese Parliament it was unanimously resolved to give extraordinary resistance to the construction of the railroad between Fusan and Seoul. The treaty by which the concession was given to the Japanese Government or to Japanese capitalists to build the railroad from Seoul to Chemulpo and from Chemulpo to Fusan was concluded in 1894 between the Japanese and Korean governments. In 1896 the concession for the former was passed over to Americans, from whom, however, it was bought back by the Japanese government. The entire road from Fusan to Seoul will be 300 miles long. When the road is completed it will be possible to reach Seoul from Shimonoseki in 20 hours, and this will be of great importance to Japanese commerce. More than half of the foreign trade of Korea is with Japan. The Seoul-Fusan line passes through the southern province of Korea, the most important and wealthiest province of the country. According to the terms of the contract, the construction of the road must be begun, at the latest, in September of next year. From Tokio comes the following information about the line from Chemulpo to Seoul: Twenty miles of this road, which, when completed, will be 26 miles long, were opened to traffic on Sept. 18 of last year. The work has been delayed by the building of a bridge of 2,700 ft. The part which is of wood (660 ft.) is already completed; the remaining 2,040 ft., which will be of iron, will be finished during this year. Japan realizes the value of the line from a strategic as well as a commercial standpoint, and will strain every nerve to have it completed at the earliest possible moment. The 20 miles now in operation produced, from Sept. 18, 1899, until the middle of December, exactly 100 days, some 15,000 yen, a receipt of 7.39 yen per mile per day. (The value of the yen is 49.8 cents.)

Super-heater for Locomotives.

While much thought is being given to removal of draft obstructions from front-ends of locomotives there are yet those who are ready to disregard this consideration by installing complicated economizers. A foreign patent recently granted to Wilhelm Schmidt, Germany, is based in part upon this description of a super-heater: A number of pipes arranged in a chamber formed of the walls of the smoke-box and inner walls of the chamber. The hot gases from the firebox enter the super-heating chamber from a large through tube, and divide into two parts at the bottom of the arch. The gases then pass over superheating pipes of small coil, to collecting boxes in the upper part of smoke-arch. These boxes are divided so that steam from throttle to cylinders passes twice through the super-heating pipes before entering the cylinders. Flap valves are also used to control the exit of the firebox gases from the super-heater. This arrangement is for a simple engine. For compound engines the device is much more complex. In the light of the present tendency to simplify draft arrangements, we fear that Wilhelm's road to success will be more tortuous and difficult than the paths of his gases.

Sailing Vessels to Carry Oil.

It is reported in New York that the Standard Oil Co. is having built, by Arthur Sewall, of Maine, two large sailing vessels for use in carrying oil to Asia, and that two similar vessels are to be built in Europe for the same company. The ships are to be full-rigged, 330 ft. long and 45 ft. beam, and will measure about 3,300 tons gross. It is said that the advances in the price of coal and of the wages of engineers which have taken place in recent years have increased the cost of transportation by steam on long ocean routes, so that it is expected that for the slow trade between New York and India sailing vessels will be more profitable than steam. The sailing vessels now employed by the Standard Oil Co. generally succeed in getting considerable return loads from Calcutta, Manila and other Eastern ports.

The City & South London Railway.

The Clapham extension of this electric railroad is now completed and is only waiting the approval of Lieut.-Col. Yorke, of the Board of Trade. Formerly the line only went so far as Stockwell, but this new section carries it to Clapham Common. The railroad now, therefore, connects Moorgate street, city, with Clapham, and when the Islington extension is opened, probably some time next year, there will be an underground service across from North to South London. This will be a great boon to the public, for up to the present there is no such service without making a variety of changes. In addition to the terminal station at Clapham Common, there is an intermediate station at Clapham Road, and at each electric passenger lifts are in use. The week-day train service on this line is now about every three or four minutes.

Machine Supplies for Japan.

German papers note that the increasing use of machines of all kinds in Japan has caused a large import of leather and rubber belts. The thriving Japanese industries also offer a good market for the export of boilers, especially tubular boilers. A great demand exists at present for drilling, planing, screw and thread-cutting machines and turning lathes.

Technical Schools.

Rensselaer Polytechnic Institute.—The commencement exercises were held June 11 to 13, and included reading a thesis on June 11, alumni meeting and excursion up the Hudson on the 13th and formal exercises in the evening of that day.

Worcester Polytechnic Institute.—The commencement exercises will be held June 17 to 21, beginning with the baccalaureate sermon on the 17th. The annual lecture before the Washburn Engineering Society will be given by Prof. Ira N. Hollis, of Harvard University, on the subject of "Armor and Guns." The commencement address, to be given Thursday, will be by Prof. Edward S. Morse, on "Can City Life be Made Endurable?"

A Large Foreign Electric Contract.

The Westinghouse Electric Mfg. Co. has a contract to equip the new electric street railroad system in Geneva, Switzerland. The original lines, 45 miles of narrow gage track in the city and suburbs, and about 17 miles of narrow gage road belonging to another company, were operated by steam locomotives and horses. The entire road was bought for $1,250,000, a reorganization effected and permission secured to build 10 miles along the shore of Lake Geneva to the village of Hermance, on the French border, and other extensions. Fifty kilometers (31 miles) of the line now being rebuilt will be opened in July.

New York City Bonds.

City Comptroller Coler wants bids on $3,135,000 of New York City bonds bearing 3½ per cent. interest. The proceeds are to be used for the following purposes: Hall of Records, $250,000; rapid transit, $1,000,000; new East River bridge, $1,000,000; Museum of Arts, Brooklyn, $300,000; Willis Ave. bridge, $500,000; new Gouveneur Hospital, $85,000.

The Bay State Limited.

The New Haven *Palladium* describes 10 new cars which have been built by the Pullman Co. for the five-hour trains of the New York, New Haven & Hartford, the "Bay State Limited," which leaves Boston and New York, respectively, at 10 o'clock in the morning. Each train consists of five cars. The forward car has no front platform, and the rear car has one alcove platform. The other platforms in the train all have wide vestibules. The cars are 78 ft. 6 in. long, including the platforms, and the total length of each train is 391 ft. 6 in. The first car has a baggage room, a buffet and four staterooms; the next three are parlor cars, and the last one is a smoking and parlor car, with another buffet. The staterooms accommodate five persons each, the parlor cars 34 each and the smoking car 39. The staterooms have doors opening from one into another, so that they can be occupied in pairs. Each room has a sofa and two chairs. This arrangement of rooms is something of an innovation on a day train, though it will be recalled that an English compartment car was run between New York and Boston about 30 years ago. The introduction of the stateroom cars at this time would seem to indicate that passengers with English ideas as to privacy in traveling are supposed to be more numerous in this country at the present time than they were in 1870. The staterooms are finished in mahogany, tiger wood, vermilion and koko. The tiger wood comes from Africa, not from New York city, and the koko wood is from India. The upholstery in the parlor cars is green figured plush. All of the cars have very broad windows, with opalescent transom lights, and there will be oval windows, filled with opalescent and jeweled glass, for the smaller rooms. The roofs of these cars will be covered with canvas duck. The cars will have steel platforms and the hoods will be flashed with copper. All the cars have Pintsch gas lamps, and a train of five cars weighs about 275 tons.

A Memorial to Mr. Toucey.

The widow of Mr. John M. Toucey has given $10,000 and the New York Central Railroad $15,000 for a building for the use and convenience of the employees of the New York Central & Hudson River Railroad, this to be situated at One Hundred and Fiftieth St. and Spencer Pl., New York, and to be known as the John M. Toucey Memorial Building. It will be under the management and direction of the Railroad Department of the Young Men's Christian Association. The enginemen and firemen and the yard employees at Mott Haven have asked the privilege of furnishing the building when it is finished, which privilege has been granted. The principal use of the building will be by these men.

Oil Burning Locomotives in New York.

The Raquette Lake Railroad, in the Adirondack region, which has a line about 18 miles long, from Clear Water, on the New York Central, eastward to Raquette Lake, is to use oil fuel in its locomotives. This line, which was built last year, runs for several miles through the state forest preserve, and the state authorities have refused to allow coal or wood-burning locomotives to be used on the road, fearing that sparks from the engines would cause forest fires.

The Railroads of Europe 1875-1899.

The table which follows has been compiled and converted from l'Economiste Europeen, of Paris, by the Philadelphia Commercial Museum, and we give it for what it is worth without attempting to verify the figures.

Railroads of Europe on Jan. 1, 1875, and Jan. 1, 1899.

	Miles, 1875. Per million of inhabitants.	Total.	Miles, 1899. Per million of inhabitants.	Total.
France	352	12,898	670	25,897
Germany	381	16,109	563	30,776
England	499	16,449	527	21,528
Austria-Hungary	273	10,083	483	21,805
Belgium	324	2,131	560	3,781
Bulgaria	324	2,131	178	616
Denmark	339	635	669	1,617
Spain	211	3,484	445	8,102
Greece	4	7	232	591
Italy	166	4,578	305	9,750
Luxemburg	827	169	1,210	270
Netherlands	261	984	329	1,694
Portugal	137	641	280	1,466
Roumania	150	766	332	1,894
Russia	126	9,665	292	24,808
Finland	249	465	604	1,605
Servia	249	465	144	353
Sweden	514	2,235	1,247	6,359
Norway	22	311	571	1,230
Switzerland	371	1,017	730	2,302
Turkey	111	953	154	978
Isles of Malta	...	...	...	...
Jersey & Man	...	...	211	68
Total	5,317	83,080	10,676	167,439

Five Proposed Railroads in Crete.

The Cretan *Official Gazette* publishes notices of concessions for building and working five railroads in the Island of Crete. The lines are metre gage and the concessions are to be for 50 years, as follows: (1.) Canae, Alikianon, Platania, Castelli, Kissamo; (2.) Canea, Suda Rethymo; (3.) Candia-Pyrghiotissa; (4.) Rethymo, Milopotamo, Gharazon; (5.) Candia, Pediada, Mirambello, Hierapetra and Candia, Gharazon. Tenders addressed to the Government of the Island of Crete, at Canea, will be received prior to July 10. No surveys have been made.

Railroad Supplies for South Australia.

Considerable railroad material will be required by South Australia. According to the "British Board of Trade Journal" bids will be received at the Supply and Tender Board Office, Adelaide, until July 4. Among the many items mentioned in the list of requirements are 2,150 solid, drawn copper boiler tubes; also a quantity of other finished iron and steel products, for which American mills can compete. Specifications and forms of tenders can be had at the office of the Locomotive Engineers, Islington, South Australia. American manufacturers having agents in London can see the specifications at the office of the Agent-General for South Australia in that city.

A New Railroad in the Azores.

Contracts are invited for building a railroad in the Azores between the cities Ponta Delgada, Valles des Furnas and Villa da Ribeira Grande. If no offer can be accepted, the Junta is authorized to build the road on its own account. Plans are to be approved by the Government. The Government concedes to the company the exploitation of the road for 99 years, which shall then become the property of the Junta General. The company is exempt from imposts, general or municipal, for 21 years after beginning the work. The Junta may be addressed as follows: A Junta da Ferrovia entre Ponta Delgada, Valles des Furnas, e Villa Ribeira Grande; Ponta Delgada, Azores.

In Honor of Judge Cooley.

The University of Michigan pays a tribute to the late Judge Thomas M. Cooley in specifying a day in the university calendar to be known as Cooley Day, and observed in an appropriate manner.

Proposed Improvements for Victoria Railroads.

A loan of £237,650 has been authorized by the Victoria Parliament in Australia for railroad improvement in that colony. Electric lighting additions at Melbourne will take £12,000; railroad shops at Newport, £2,000; railroad scales at various stations, £5,000; heavier rails on various lines, £6,200; substituting bridges for level crossings on eight lines, £42,600; Westinghouse airbrakes, £15,000; improvement of lights in cars, £6,000; new machinery and tools, £7,000; filtering plant for provisions and ice water, £1.100.

South American Notes.

The house of Glyn, Mills & Co., of London, has agreed to furnish funds for constructing the Guayaquil-Quito Railroad, Ecuador. Mr. Harmon, the Concessionaire, is now in Guayaquil, and work will soon begin. Contracts have been made for 1,200 Jamaica negroes, and 30,000 tons of rails, and 15,000 tons of bridge steel have been ordered to start the work. Orders will soon be given for locomotives and other rolling stock.

Surveys are being made in the interest of the Chilean Government for a railroad from Vina del Mar to San Pedro and Quintero, via the popular seaside resort of Concon.

The Chilean Government is asking for tenders for a narrow gage railroad from Talca to San Clemente, and for branch lines from Choapa to Illapel, and from Tennico to Carahue. The plans and estimates of a line from

Pueblo Hundito to Inca de Oro have been approved. The cost is put at $730,000.

Clark's Transandine Railroad has been sold to Eliseo Gutierrez, representing a syndicate of banking interests, including the Banco de Chile, Banco Comercial, Banco de Santiago, and Edward's Bank. It is rumored that the Government will take over this line and complete it.

The Brazilian Minister of Public Works is asking for tenders for the establishment of a new steamboat service from Montevideo up the River Paraguay to the City of Cuyabá, in Matto Grosso. The route will be 2,400 miles in length. The mines in Matto Grosso are attracting attention, and there will apparently be a large development of trade in that region in the near future.

The cable between Para and Mariaos up the River Amazon, which has been out of service for two years, has now been repaired, and is again in working order.

The borax deposits near Jujuy, Argentine, are to be opened up in October. In order to render them accessible a branch line, from the Central Norte line, 115 miles long, will be constructed. An aerial tramway line 4 miles long will also be built across Purma Maria.

LOCOMOTIVE BUILDING.

The Atlanta & West Point is having 1 engine built by the Rogers Locomotive Co.

The Arkansas Southeastern has ordered 1 locomotive from F. M. Pease, of Chicago.

The Quincy Mining Co. has ordered one engine from the Baldwin Locomotive Works.

The Cleveland, Cincinnati, Chicago & St. Louis is reported in the market for locomotives.

The Minister of Railroads of Italy has granted the Meridional, Mediterranean and Sicilian Railroad Companies permission to ask bids on 123 locomotives.

The Missouri Pacific, as noted June 1, has ordered 30 10-wheel locomotives from the Brooks Locomotive Works. Eight of these will have 19-in. x 26 in. cylinders; 66-in. drivers; 200-lbs. working steam pressure and a total weight in working order of 142,000 lbs., of which 112,000 lbs. will be eon the drivers. The boilers will be of the wagon top type, with 260 iron tubes, 2 in. in diam. and 13 ft. 6 in. long. The fire-boxes will be of steel, 114 in. long and 41 in. wide. Water tank capacity, 4,500 gals.; coal capacity, 8 tons. The other 22 will have 20-in. x 26 in. cylinders; 60-in. drivers; 200 lbs. steam pressure; and a total weight in working order of 160,000 lbs., of which 124,000 lbs. will be on the drivers. The boilers will be of the wagon top type, with 275 iron tubes, the same size as the others. The fire-boxes will also be of the same dimensions. The water tank capacity will be 5,000 gals. and the coal capacity, 8 tons. The special equipment for all includes Westinghouse air brakes, steel axles, National hollow brake beams, Pyle electric headlights, U. S. Metallic packing, Coale safety valves, Leach sanders, Nathan lubricators, Pickering springs, Star steam gages, and Safety steam heat equipment.

CAR BUILDING.

The Erie is reported to have ordered 1,000 box cars from the Pressed Steel Car Co.

The Crystal River has ordered 40 cars from the American Car & Foundry Co.

The Mount Vernon Car Mfg. Co. is asking bids for material on 200 box cars.

The Pittsburgh Coal Co. has ordered 100 cars from the Youngstown Car Mfg. Co.

The Louisville, Henderson & St. Louis has ordered 7 cars for passenger service from the American Car & Foundry Co. They will be built at Jeffersonville.

The Minister of Railroads of Italy has granted the Meridional, Mediterranean and Sicilian Railroads permission to ask bids on 460 baggage and 2,673 freight cars.

The Choctaw, Oklahoma & Gulf has ordered 250 coal, 160 box and 25 furniture cars from the Mt. Vernon Car Mfg. Co. Simplex bolsters have been specified for all equipment.

The Cleveland, Cincinnati, Chicago & St. Louis has ordered 300 coal cars, of 80,000 lbs. capacity, from the American Car & Foundry Co. Schoen trucks and body bolsters are specified.

F. M. Pease, of Chicago, has received the following orders for cars: Brittain & Co., 3 tank cars; Johnson Cooperage Co., 2 furniture cars; Shippers' Refrigerating Car Co., 4 poultry and 10 additional refrigerator cars; International Construction Co., 10 flat cars; Tionesta Valley Ry. Co., 39 gondola and 13 flat cars; Bellaire, Zanesville & Cincinnati Ry., 2 passenger coaches, 1 mail and baggage coach, 1 baggage and 8 gondola cars; and for 1 passenger coach for export.

BRIDGE BUILDING.

Belton, Tex.—The Commissioners' Court has ordered an election to decide if the county shall be taxed to rebuild the bridges destroyed by the floods.

Boise, Id.—The County Commissioners have let the contract to the Gillette-Herzog Mfg. Co. for the new bridge to be built at Government Island at $15,335.

Buffalo, N. Y.—Bids are wanted until June 16 for a viaduct over the Western New York & Pennsylvania in Babcock St. by Frank V. E. Bardol, Chief Engineer of the Grade Crossing Commission.

Cape Breton, P. E. I.—The Canso & Louisburg Ry. will build a bridge over the River Inhibetant on its proposed railroad. Col. Henry Alton, 31 Broad St., New York, is Vice-President and General Manager.

Castoria, O.—Bids are wanted until July 2 for a bridge over Island Creek which will cost about $10,000. Frank Stokes, County Clerk.

Chicago, Ill.—Local reports state that City Engineer Ericson has appointed Ralph Modjeski, E. L. Cooley and Byron B. Carter on the commission to examine the plans for bascule bridges.

Cincinnati, O.—The County Commissioners have been petitioned for two bridges across Dunlap Creek on the road between Dunlap and Miami. Frank Krug, County Commissioner, has the matter in charge.

Clarkton, Va.—Bids are wanted at once on an iron bridge 300 ft. over all across the Staunton River, the dividing line between Halifax and Charlotte counties. T. B. Clark, of Clarkton, is acting clerk of the joint commission.

Cleveland, O.—The County Commissioners have decided to rebuild the bridge at Eight-mile Lock at an estimated cost of $13,000.

Davenport, Wash.—Bids will be received by the County Commissioners until July 9 for a new wagon bridge across the Spokane River at the old bridge site, one mile below Fort Spokane. It will have two spans of 145 ft. each and 153 ft. of pile approaches. Estimates are requested on three kinds of bridges, wooden, iron, and combination. J. W. Anderson, Auditor, Lincoln County.

Elgin, Ill.—The Toledo Bridge Co., according to report, has the contract for the superstructure of the Chicago St. bridge at $35,534. Contract for the foundations for both the Chicago and National St. bridges is let to John C. Darst.

Fargo, N. D.—Reports state that a steel bridge is proposed at a cost of $10,000.

Fort Worth, Tex.—Bids will probably be advertised for in about 60 days by John B. Hauley, City Engineer, for a wooden bridge 1,200 ft. long over the Texas & Pacific Ry., estimated to cost $25,000.

Grand Detour, Ill.—Bids are wanted until June 19 for the proposed bridge over Rock River. C. C. Jacobs, Engineer.

Grand Rapids, Mich.—The Pere Marquette wooden bridge over the Grand River, according to report, will be replaced with a steel structure.

The Board of Public Works has been ordered to secure bids for the piers for the Wealthy Ave. bridge. The City Engineer has prepared estimates for a draw bridge from the corner of Wealthy Ave. and South Front St., to Godfrey Ave. and South Market St. The total cost of the piers will be $20,658. One plan is to remove the Bridge St. bridge and rebuild it at Wealthy Ave. on new piers.

Guelph, Ont.—The bridge over the canal at Somerset St. will be built by the Ottawa Improvement Commission when the work on King St. is finished.

Hattiesburg, Miss.—The Board of Supervisors of Perry County has authorized an issue of $20,000 of 6 per cent. bonds for new county bridges.

Kansas City, Mo.—The St. Louis & San Francisco R. R. will rebuild all the bridges on the Kansas City, Osceola & Southern, recently bought by the St. L. & S. F. (See Railroad Construction column.)

Lafayette, Ind.—The Chicago, Indianapolis & Louisville has let a contract to the Lafayette Bridge Co. for two bridges over the Wabash River, one at Lafayette, which will be 316 ft. long, and another at Delphi, Ind., which will be 602 ft.

Lewiston, Cal.—New bids will probably be wanted at the July meeting of the County Commissioners for the steel bridge over Trinity River, as the bids opened May 21 were rejected. R. L. Carter, Clerk of the Board of Supervisors, Weaverville, Cal.

Louisburg, N. C.—Bids are wanted until June 16, according to report, for an iron bridge 390 ft. long for Franklin County. A. J. P. Harris, County Commissioner.

Louisville, Ky.—The Louisville Trust Co. will build a bridge to connect its building with the second floor of the County Courthouse annex, now building.

Marysville, Cal.—The Southern Pacific has let a contract to the Phoenix Bridge Co. for a steel bridge 920 ft. long over the Yuba River for the Central Pacific Ry. It will be of deck plate girders on foundations built by the company. (See also Wheatland.)

Morgantown, W. Va.—The Monongahela County Court has appropriated $26,000 for a bridge across the Cheat River at Uneva.

Napanee, Ont.—The County Council and the Township Council, we are informed, propose to buy two bridges at once, one to be located at Mink's bridge, about three miles from Napanee, and the other to be located at Camden East, both to cross the Napanee River. W. G. Wilson, County Clerk, Napanee, Ont. (Feb. 23, p. 126.)

Newport News, Va.—Bids are wanted by E. I. Ford, Chairman of the Bridge Committee, at the Mayor's office, until July 7, for the steel viaduct over the Chesapeake & Ohio R. R. track at Twenty-eighth St. We are informed that the bridge will be about 900 ft. long and is estimated to cost $60,000. Bids are asked on plans adopted by the city and on "Cooper" specifications of 1896.

New York, N. Y.—A steel bridge will be built across the channel at the Brooklyn Navy Yard to supersede the ferryboat now in use. The bridge will cost about $115,000.

Oldtown, Me.—The Maine Central has let a contract to the Boston Bridge Works for a steel bridge 150 ft. long over Penobscot River. It is a single-track, through lattice truss of one span.

Orono, Me.—The Pennsylvania Steel Co. has a contract from the Maine Central for a 615-ft. steel bridge over Stillwater River. It will be a double-track structure of one deck plate girder span and four through pin-connected Pratt trusses.

Ottawa, Ont.—An overhead bridge is petitioned for in the village of Hintonburg over the Canadian Pacific and the Canada Atlantic railroad tracks. It will probably be located at Fourth Ave.

Paterson, N. J.—The F. R. Long Co.'s bid of $40,850 is the lowest for the Sixth Ave. bridge over the Passaic River. The other bids were: Variety Iron Works, $43,000; Youngstown Bridge Co., $45,900; Wrought Iron Bridge Co., $44,000; Dean & Westbrook Co., $41,500; King Bridge Co., $43,975; Berlin Iron Bridge Co., $41,200. (May 25, p. 346.)

Perth Amboy, N. J.—A commission appointed to consider the advisability of a bridge over Woodbridge Creek, has reported in favor of building at a cost of $10,000. Robert Dougherty, Engineer.

Philadelphia, Pa.—The bill permitting the Pennsylvania R. R. to build a bridge over Market St., connecting the Broad St. Station with a new building opposite, has become a law.

Portland, Me.—The committee considering the Vaughan bridge matter, estimates that to make temporary repairs would cost $18,000; to build a new steel bridge, $230,000; to build a pile bridge with a steel draw, $133,000.

Providence, R. I.—The Rhode Island Legislature has passed a bill permitting the N. Y., N. H. & H. to build a bridge across the Seekonk River at India St. It is to be a double-track bridge and must have a draw not less than 80 ft. wide. The railroad company informs us that nothing definite has been decided, as further legislation is needed.

Quincy, Cal.—Proposals will be received until July 2 for an iron bridge over Shipman's Cut, Seneca Township. H. C. Flournoy, Clerk of Plumas County.

Salt Lake City, Utah.—The Rio Grande Western has let contracts to the Louisville Bridge & Iron Co. for three steel bridges, each 82 ft. long, one to cross Spanish Fork River at Castilla; another Price River at Woodside and the third Salt Wash at Ruby. Another bridge of 114 ft. will cross Provo River near Provo, Utah.

Snohomish, Wash.—Bids are wanted, June 16, by the County Commissioners for a bridge across Philchuck Creek, near Snohomish. T. E. Headlee, Clerk, Everett, Wash.

Springfield, O.—The Dayton, Springfield & Urbana Ry. is reported considering with the Board of Public Affairs the advisability of bridging Black Creek at Fountain Ave.

A bridge is reported under consideration over the Ohio Southern at Plum St.

St. Paul, Minn.—Local reports state that the University Ave. bridge will soon be rebuilt. O. Clausen, City Engineer.

Congress has passed the bill authorizing a bridge across the Mississippi River at St. Paul by the South St. Paul Belt Ry. Co. (April 12, p. 243.)

St. Stephen, N. B.—A meeting was held recently in St. Stephen to take action in regard to the proposed railroad bridge across the St. Croix River to connect the Shore Line Ry. with the Washington County R. R.

Terre Haute, Ind.—Bids are wanted on June 21 for seven county bridges varying in length from 22 ft. to 60 ft. James Soules, County Auditor.

Three Rivers, Que.—Bids are wanted June 25 by L. T. Désaulniers, Secretary and Treasurer of the corporation of Three Rivers, for a steel bridge 1,383 ft. long over the St. Maurice River.

Wheatland, Cal.—The Phoenix Bridge Co. has a contract from the Southern Pacific Co. for a steel bridge 360 ft. long over Bear River. It will be of deck plate girders on cylinder piers. (See also Marysville.)

Xenia, O.—The Mt. Vernon Bridge Co. has the contract for the 128-ft. steel highway bridge for which 20 bids were received June 7. (June 1, p. 363.)

Other Structures.

Bonham, Tex.—The Texas & Pacific will build a new station at South Main St., Bonham.

Boston, Mass.—The West Branch Corporation of Beverly has petitioned the Harbor & Land Commission for permission to build a pier about 700 ft. long at a point called the "Kop."

Buckingham, Va.—A contract will be let in a few days for steel for a fire-proof vault in the Buckingham County Clerk's office at Buckingham. S. R. Gouet, County Clerk.

Buffalo, N. Y.—The Lackawanna Iron & Steel Co. has received a grant of 310 acres under water from the State Land Board at $20 per acre. The land adjoins the site of the new plant of the steel company.

Columbia, S. C.—The contract for grading the Union Depot site at the foot of Main St. has been let to W. H. Jeffords, of Columbia. About 56,000 cu. yds. of material will have to be removed.

Ensley, Ala.—The Tennessee Coal, Iron & Railroad Co., according to local reports, will build a rail mill at Ensley, adjacent to its steel plant.

Jackson, Ga.—The State Railroad Commissioners have been petitioned by the city officers to have the Southern Ry. build a new station in Jackson.

Monongahela, Pa.—The Monongahela Consolidated Coal & Coke Co. is reported to have under consideration building a plant in the Monongahela Valley to make steel coal and coke barges.

Passaic, N. J.—The Delaware, Lackawanna & Western R. R. will build a new passenger station in Passaic at a cost of about $25,000. Part of the land was given by the city.

Pittsburgh, Pa.—Work has been begun by the Park Steel Co. on its new plant at West Elizabeth, Pa. The new works will comprise four 50-ton open-hearth furnaces, a puddling mill and crucible furnaces. Reports state that considerable of the equipment has been secured.

Seattle, Wash.—The Pacific Coast Co. is reported having plans made for improvements to its water front property which will cost about $350,000. The improvements include warehouses, slips and wharves.

Welland, Ont.—The plant of the Canadian Steel Co., recently organized, will be located at Welland. F. E. Hinckley, Vice-President of the company, is reported as stating that when completed the plant will cost about $25,000,000, and that preparations are now being made to begin the work. The company is reported already to have bids covering practically all parts of the work. The company owns 200 acres of land for a site on the Welland Canal. Of the authorized capital stock, $4,000,000 is preferred. The directors are: E. A. C. Pew, of Toronto; F. E. Hinckley, of New York; John H. Hardabeck, of Kankakee, Ill., and John H. Hardabeck, James Young, and E. M. Butz, of Pittsburgh. E. A. C. Pew is President, and F. E. Hinckley, Vice-President.

MEETINGS AND ANNOUNCEMENTS.

(For dates of conventions and regular meetings of railroad associations and engineering societies see advertising page xiii.)

Central General Baggage Agents.

An association with this title has been formed by the general baggage agents of the roads in the Central Passenger Association. The chairman is Mr. R. R. Bentley, Pennsylvania Lines, Pittsburgh.

The Mechanical Conventions.

The annual convention of the Master Car Builders' Association will open at the Grand Union Hotel, Saratoga Springs, N. Y., at 10 a. m., Monday, June 18, and will hold daily sessions until the 21st, on which date the

American Railway Master Mechanics' Association will hold their annual convention, beginning at 9 a. m., and remain in session until June 23d.

American Foundrymen's Association.

The American Foundrymen's Association, at Chicago, Ill., elected on June 7 the following officers: President, W. A. Jones, Chicago; Secretary, Dr. R. G. Moldenke, Pittsburgh; Treasurer, Howard Evans, Philadelphia; Vice-Presidents, G. H. Buckingham, Worcester, Mass.; William Yagle, Pittsburgh; J. P. Golden, Columbus, Ga.; J. A. Penton, Detroit; William Ferguson, Chicago; W. S. Mosher, Dallas, Tex.; R. Chartrey, San Francisco, and T. J. Bast, Montreal.

American Society of Civil Engineers.

At the regular meeting held on the 6th Mr. Kummer's paper on "The Preservation of Timber," was read for discussion. We recently gave a careful abstract of this paper. The discussion was long enough, but did not develop anything of importance, except perhaps to show that those who discussed the matter did not know any more about it than most of the rest of us.

The next regular meeting of the Society (other than the summer convention at London) will be held Sept. 5, when Mr. Mead's paper on "Irrigation" will be presented for discussion.

Traveling Engineers' Association.

The committee of the Traveling Engineers' Association appointed to make arrangements for the next annual convention met in Cleveland June 9. The convention will be held there, beginning Sept. 11. The New Colonial Hotel will be the headquarters, and the convention hall will be in that hotel. It is believed that this convention will be the largest and most interesting yet held by the association, and the committee of arrangements is taking great pains to make the occasion enjoyable. This committee is as follows: C. H. Stalker, L. S. & M. S. Ry., chairman; P. J. Hickey, C., C., C. & St. L.; W. E. Bryant, Detroit Lubricator Co.; W. O. Thompson, Hancock Inspirator Co.; D. M. Winegar, Erie R. R., and C. E. Houghton, Lunkenheimer Co.

International Mining Congress.

The programme for the International Mining Congress, at Milwaukee, Wis., June 19 to 23, is partly as follows:

Tuesday—Opening address by President; address by Hon. Edward Scofield, Governor of Wisconsin; address by Hon. David S. Rose, Mayor of Milwaukee.

Wednesday—Appointment of committees for permanent organization of association. Papers: "Department of Mining," Hon. L. Bradford Prince, Santa Fé, ex-Governor of New Mexico; "Public Survey of Mineral Lands," Paul Clagstone, Stehekin, Wash.; "Lead and Zinc Industry in Missouri," Edward M. Shepard, Springfield, Mo.; "Progress and Development of Mining in Western Ontario," T. R. Deacon, Rat Portage, Ontario.

Thursday—Papers: "Mining in the East," John W. Postgate, New York; "Mines and Minerals of Southern Wisconsin," Richard Kennedy, Highland, Wis.; "Revision of Mining Laws," Chas. J. Moore, Cripple Creek, Col.; "Why Women Should Interest Themselves in Mining," Mrs. E. C. Atwood, Empire, Colo. Afternoon—Trolley car excursion to the E. P. Allis Co.'s plant and the breweries.

Friday—Papers: "Wisconsin Building Stones," E. R. Buckley, State Geologist, Madison, Wis.; "Mining as an Investment," N. C. Westerfield, St. Paul, Minn.; "Copper Mining in Northern Wisconsin," Kirby Thomas, West Superior, Wis.; "Tennessee as a Mining Field," Henry V. Maxwell, Knoxville, Tenn.

Saturday—Papers: "Treatment of Ores," L. D. Godshall, Spokane, Wash.; "Mining, Mine Managers and Inspectors of Mines," Henry J. Brennan, Mayor, Carbondale, Pa.; election of officers, etc.

PERSONAL.

(For Other personal mention see Elections and Appointments.)

—Mr. John Newbold Hazard, President of the Narragansett Pier Railway, died at Peacedale, R. I., June 7, aged 64 years. Mr. Hazard was formerly President of the Peacedale Mfg. Co.

—Mr. Y. Sasaki, Manager of the Nankai Railroad, of Japan, is here studying American methods of transportation. He will leave New York shortly, and, after visiting Washington and Chicago, will leave the last of June from San Francisco for Japan. Mr. Sasaki left home last November and has visited all the principal cities in Europe.

—Mr. K. Nishino, Traffic Manager of the Sanyo Railroad, of Japan, is now in Philadelphia. He left Japan last November and has made a study of the railroads of all the countries in Europe. Mr. Nishino will spend about two months here, giving special attention to the methods of conducting the transportation department of American railroads.

—Mr. Archie M. Quarrier, Second Vice-President of the Louisville & Nashville, died at his home, No. 809 Madison Ave., New York, June 11. Mr. Quarrier has given his working life to the Louisville & Nashville, having been with that company for over 40 years. He was born at Ravenswood, W. Va., Aug. 22, 1841. In 1858 he entered railroad service with the Louisville & Nashville as a clerk in the Secretary's office. A few months later he was advanced to book-keeper, which position he held until July 18, 1871, when he was appointed Assistant Secretary. In April, 1880, he received the added duties of Assistant to the President. He was made Second Vice-President Oct. 1, 1884, the position he held at the time of his death. Mr. Quarrier was a member of the Lawyers' Club and the New York Athletic Club of New York, and the Pendennis Club, of Louisville, Ky. He was Vice-President and Treasurer of the American Pig Iron Storage Warrant Co.; Vice-President of the Henderson Bridge Co., and Vice-President of the Nashville, Florence & Sheffield R. R. His brother, Cushman I Quarrier, is Comptroller of the Louisville & Nashville.

—Among the honors bestowed on the Queen's birthday Mr. Claude William Kinder gets a C. M. G. (Companion of the Order of St. Michael and St. George). Mr. Kinder, as our readers know, is Engineer-in-Chief and Superintendent of the Imperial Chinese Railways, his headquarters being at Tien-Tsin. He is also a member of the American Society of Civil Engineers and of the Institution of Civil Engineers (British). Mr. Kinder has earned this distinction about as well as any man of whom we know. It must be now well on to 30 years since he began the struggle to create railroads in China, and that struggle he has carried on with pertinacity, tact, skill and ability ever since, and almost every foot of railroad now existing in China, not including, of course, the new Russian railroads in Manchuria, has been built by Mr. Kinder or with his counsel and advice. In times past we have given a pretty careful account of his earlier work, and shall not repeat that now. For the last year or two there has been an effort on the part of the Russians to get rid of Mr. Kinder, who is not a convenient person for them to have about in that part of the world. So far as we are informed, however, he still keeps his power and influence, and for the good of China we hope that he long may.

ELECTIONS AND APPOINTMENTS.

Allegheny Valley.—J. M. Harding has been elected Secretary, with headquarters at Philadelphia, Pa., succeeding S. W. White.

American-Mexican Pacific.—The officers of this company referred to in the Construction column are: Vice-Presidents, W. W. Williams, Lyman Bridges, O. P. Widerman; Treasurer, John Gardner; Secretary, J. L. Powell; Auditor, H. H. Pilling; Chief Engineer and General Manager, Lyman Bridges; Solicitors, W. A. Barnes and S. W. Purcell. The main office is at Tucson, Ariz.

Birmingham & Atlantic—W. L. Law has been appointed Superintendent and General Freight Agent. Burt W. Armstrong has been appointed General Passenger Agent, effective June 6.

Butte, Anaconda & Pacific.—H. E. Moran has been appointed General Freight and Passenger Agent, with headquarters at Anaconda, Mont.

Caldwell & Northern.—J. C. Williams has been appointed General Manager, with headquarters at Lenoir, N. C., succeeding L. C. Watson.

Carrabelle, Tallahassee & Georgia.—J. P. Contrell has been elected Secretary and Treasurer, succeeding R. L. Murray.

Central of Georgia.—A. Johnson has been appointed Engineer Maintenance of Way, with headquarters at Savannah, Ga.

Chicago, Milwaukee & St. Paul.—R. M. Calkins, Assistant General Freight and Passenger Agent at Des Moines, Ia., has been appointed Assistant General Freight Agent of the entire line, with headquarters at Chicago, Ill., succeeding A. B. Bridges, who has been transferred to Milwaukee, Wis. Mr. Calkins also retains direct supervision of freight matters on the Des Moines Division.

Dayton, Lebanon & Cincinnati.—E. F. Gray has been appointed General Freight and Passenger Agent and J. C. Gleason, Superintendent, with headquarters at Lebanon, O.

Delaware & Hudson.—W. R. Johnson, heretofore Master Mechanic, has been appointed Master Car Builder, succeeding J. H. Orchard, who has become Foreman of the car shops.

Erie.—G. G. Cochran, heretofore Fourth Vice-President, has been appointed Western Freight Traffic Manager, with headquarters at Cleveland, O., in charge of lines west of Salamanca. Frank Harriott, heretofore General Freight Traffic Manager, has been appointed Eastern Freight Traffic Manager, with headquarters at 21 Cortlandt St., New York, in charge of lines east of Buffalo and Salamanca. Mr. Cochran has also been appointed Freight Traffic Manager of the Chicago & Erie, succeeding Mr. Harriott, resigned, effective July 1.

Florida Central & Peninsular.—C. B. Royal, heretofore Master Mechanic of the Seaboard Air Line, has been appointed Master Mechanic of the F. C. & P., with headquarters at Jacksonville, Fla.

Gila Valley, Globe & Northern.—D. R. Boardman has been appointed Master Mechanic, with headquarters at Globe, Ariz.

Gulf & Interstate Ry. of Texas.—T. J. Ray has been appointed Superintendent, with headquarters at Port Bolivar, Tex.

Gulf & Ship Island.—The headquarters of J. T. Jones, President, have been removed from Bradford, Pa., to Buffalo, N. Y.

Interoceanic Ry. of Mexico.—C. E. Scruby has been elected Secretary, with headquarters at London, Eng., succeeding G. W. Hoghton.

Long Island.—At a meeting of the stockholders, held June 11, Frank L. Babbott, James Timpson, Joseph S. Auerbach and A. C. Bedford, Directors of the L. I., resigned and the following representatives of the Pennsylvania were elected to fill the vacancies: John P. Green, Charles E. Pugh, S. M. Prevost and C. M. Bunting. Samuel Rea will, upon his return from Europe, succeed Mr. Bunting. Messrs. Green, Pugh, Prevost and Rea are now First, Second, Third and Fourth Vice-President, respectively, of the Pennsylvania.

Louisville & Nashville.—For the present, J. A. Boyd, Assistant General Passenger Agent at Louisville, Ky., will assume the duties of General Passenger Agent.

Michoacan & Pacific.—E. W. Knapp, Master Mechanic, has resigned.

Mississippi River, Hamburg & Western.—J. H. Schaefer has been appointed General Freight and Passenger Agent, succeeding George Helme, resigned.

Mobile & Ohio.—C. W. Gibson, Assistant General Traffic Manager, with headquarters at Mobile, Ala., has resigned.

Modesto & Yosemite Valley.—The officers of this newly-incorporated company are: President, Louis Kahn; Vice-President, John F. Tucker; Secretary, George Perley and Treasurer, Frank A. Cressey. (See R. R. Construction column, June 1, p. 364.)

Muscatine North & South.—Charles Howard has been appointed General Manager, succeeding J. A. Nelson, resigned. George Reeder has been appointed Audtior. Their headquarters will be at Muscatine, Ia.

Norfolk & Western.—S. M. Prevost, Third Vice-President of the Pennsylvania, has been elected a Director of the N. & W., succeeding William E. Glyn, resigned.

Pacific Coast.—J. F. Trowbridge, General Freight and Passenger Agent at Seattle, Wash., has resigned.

St. Louis & San Francisco.—On Thursday, June 7, B. F. Yoakum, heretofore Vice-President and General Manager, was elected President and General Manager, succeeding D. B. Robinson, who resigned as President on account of ill health. Alexander Douglas was elected Vice-President and General Auditor, and C. H. Beggs, Vice-President and Assistant to the General Manager. Mr. Beggs was formerly Purchasing Agent.

Terminal R. R. Association of St. Louis.—John W. Taylor, heretofore Engineer Maintenance of Way, has been appointed Chief Engineer of this company and the St. Louis Merchants' Bridge Terminal, effective June 1. He is also in charge of Maintenance of Way and Structures. The positions of Engineer Maintenance of Way and Superintendent of Structures have been abolished.

Union Pacific.—W. H. Peterson has been appointed Supervisor of Bridges and Buildings, with headquarters at Cheyenne, Wyo., succeeding A. H. King, transferred.

RAILROAD CONSTRUCTION.

AMERICAN-MEXICAN PACIFIC.—The route of this proposed line is from Phoenix, Ariz., southwest 1,050 miles, via Florence and Tucson, Ariz., and Callabarsas (near Nogales), Sonora, Sinaloa and Tepee, to Jalisco, Mex., on the Baranderas Bay, with 300 miles of branches, to Deming and St. George Bay on the Gulf of California. The line is being located through mineral districts and timber and cattle lands. The company expects to begin grading in July and to have 100 miles of track laid during the present year. The officers are given under Elections and Appointments. (Official.)

BELLINGHAM BAY & EASTERN.—The City Council of Fair Haven, Wash., has granted the application for right of way for this company along the water front. (June 8, p. 379.)

CALIFORNIA & NORTHWESTERN.—Grading is reported begun at Eureka, Cal., on this line from Eureka to run north about 40 miles via Arcata to Crescent City. Chas. Nelson, of San Francisco, and D. B. Lyman, of Reno, Nev., are among the incorporators. (April 13, p. 245.)

CANSO & LOUISBURG.—Work is in progress on this line in Cape Breton, N. S., from Hawkesbury via St. Peters, L'Ardoise and Grand River to Louisburg. Henry Alton, 32 Broad St., New York, is General Manager. Isadore Le Blanc, M. L. C., of Arichat, Cape Breton, is interested. (March 2, p. 145.)

CHICAGO & NORTHWESTERN.—Surveys are reported in progress for an extension from Waukesha, Wis., to run northwest 40 miles via Pewaukee, Merton, North Lake and Juneau to Beaver Dam.

CORNWALL & LEBANON.—An officer confirms the statement that the company is extending its double track from Colebrook, Pa., to Lawn, two miles. Double track is also in progress on the Lake Conewaygo Branch from its junction with the main track just north of Colebrook to the State Rifle Range, three-fourths mile; also on a new siding on the Conewaygo yard 2,800 ft. long. The contract for grading is held by Humphreys & Rowe, Lebanon, Pa. Rails will be laid by the company. Work is about half completed and should be finished within six weeks. There are no bridges other than one or two open culverts. New securities will not be issued. (June 8, p. 380.)

DELAWARE, LACKAWANNA & WESTERN.—An officer denies knowledge of any proposed branch from Factoryville, Pa., to Lake Winola. (June 8, p. 380.)

DENVER & RIO GRANDE.—Work has been resumed on the Rio Grande, Pagosa & Northern line from Gato, Col., northeast 33 miles, to Pagosa Springs and thence to Alamosa. Thirteen miles was completed last year. (Dec. 8, 1899, p. 853.)

DETROIT & TOLEDO SHORE LINE.—W. B. Strang, of Toledo, O., announces that work is to be resumed within 30 days on this line between Toledo and Detroit. Several miles of track was completed last year under the Ferguson Contracting Co., New York. Mr. Strang has the contract. (July 28, 1899, p. 547.)

EAST SHORE.—This company has been incorporated in New York, with a capital stock of $10,000, to build a steam road from Poughkeepsie to the Hudson River Hospital. The Directors are: James L. Williams and Chas. Hicks, Poughkeepsie; E. C. H. Rand, New York City.

EL PASO & NORTHEASTERN.—New surveys have been ordered for the proposed extension into Kansas. One route is from Capitan, N. M., north about 250 miles to Liberal, Kan. Another is from White Oaks, N. M., via Texline, to Liberal, and a third is to Los Vegas.

GRAND RAPIDS, SPRING LAKE & GRAND HAVEN RAPID TRANSIT.—The route of this proposed electric line is from Grand Rapids, Mich., west about 31 miles, via Tallmadge, Lamont, Eastmanville, Ottawa Center and Dunton to Grand Haven, paralleling the Grand Trunk. It is to be used for passenger and freight traffic. (May 25, p. 348.) Justin R. Whiting, of St. Clair, Mich., is President, and Byron E. Parks, Grand Rapids, Chief Engineer. (Official.)

GRAND TRUNK.—The company is soon to make extensive improvements at London, Ont. Double track will be laid from London east to Komoka; also additional tracks and extensions of the yards at Allandale. (March 16, p. 177.)

The Railroad Committee of the Dominion Parliament has adopted the bill of incorporation for the Ottawa, Brockville & St. Lawrence, which is to form the connecting link for the Grand Trunk System into Ottawa. The line will run through Carleton, Greenville and Leeds Counties, and will connect with Merrickville on the Canadian Pacific. The capital stock is $500,000, and the road is bonded at $25,000 a mile. Power is granted to operate ferries across the St. Lawrence from Brockville to Norristown, to connect with the American lines, and to generate electricity at the several water powers along the Rideau and to transmit it to the towns along their line. (Sept. 1, 1899, p. 619.)

GULF & MANITOBA.—A trust deed to the Iowa Loan & Trust Co., of Des Moines, Ia., for $21,000,000, has been filed for building this proposed line from Duluth, Minn., south 700 miles to Kansas City. Frank T. Campbell, of Beaver Falls, Minn., is President. (May 4, p. 295.)

GULF & SHIP ISLAND.—Messrs. Camp, Hinton & Co. have a contract for a section of the Columbia, Lumberton & Gulf between Columbia, Miss., and Hub, 22 miles. (Nov. 24, 1899, p. 819.)

ILLINOIS CENTRAL.—It is reported that the company will build 51 miles of double track this summer through Champaign, Mattoon, Effingham and Centralia, Ill. Work is reported begun at Champaign.

ILLINOIS SOUTHERN.—This company, successor to the Centralia & Chester, is reported about to build an extension from Salem, Ill., via Sailor Springs to Terre Haute,

Ind., to connect with the new branch of the Southern Indiana.

Laramie & Sweetwater.—This company, incorporated about three months ago in Wyoming, with a capital stock of $4,000,000, proposes to build a railroad from Fort Laramie, on the Chicago, Burlington & Quincy's new line to Guernsey, to run southwest 200 miles via Wheatland, on the Colorado & Southern, to Betherton, on the Sweetwater River. N. R. Davis is President, and J. D. Negus, Vice-President, both of Cheyenne.

Lehigh Valley.—An officer writes that the company has no intention of building a third track between Coxton, Pa., and Tunkhannock. (June 1, p. 364.)

Louisville & Nashville.—C. D. Smith & Co., of Birmingham, Ala., have taken the contract for nine miles of the Oneonto & Attella, which is to run from Oneonto, Ala., northeast about 25 miles to Attella. The work is to be completed within 90 days. (O. & A., June 8, p. 380.)

The company has asked for right of way for additional switch and track privileges at New Orleans, La.

Manitoulin & North Shore.—Work is in progress for about 25 miles west of Sudbury, Ont., on this proposed line from Sudbury west about 66 miles to Little Current. The contractors are Foquhar Bros. No officers as yet are elected. Hearst & McKay, of Sault Ste. Marie, Ont., are the solicitors. (April 27, p. 280.)

Massachusetts Roads.—The Government Navy Yard is having 400 tons of rails delivered for a railroad. Congress has appropriated about $50,000 for the work.

Missouri, Kansas & Texas.—An officer writes that the company does not intend to build a spur, as reported, to Brandon, Tex. (June 1, p. 364.)

Modesto & Yosemite.—Surveys are to be begun soon for this line from Oakdale, Cal., via Clauston, Modesto and Newman to tidewafer, 100 miles. It is expected to begin grading Aug. 1. The officers are given under Elections and Appointments.

Monongahela Southern.—The Carnegie Steel Co., according to report, has decided to build this line as a feeder to the Pittsburgh, Bessemer & Lake Erie, from Duquesne, Pa., southwest 21 miles. (Dec. 15, 1899, p. 872.)

Natchitoches & Grand Ecor Railway & Bridge.—The date for opening bids for the bonds of the Natchitoches Railway & Construction Co. has been changed from June 11 to Aug. 6. The road as projected is from Grand Ecor, La., across the Red River. D. C. Scarborough is President, and Simcoe Walmsley, Secretary, both of Natchitoches, La. (Aug. 18, 1899, p. 589.)

New York Roads.—The Government will build a railroad across Brooklyn Navy Yard, for which Congress has appropriated about $30,000.

The Lackawanna Iron & Steel Co. is preparing to build a railroad six miles long from its plant at Stony Point to connect with railroads at Buffalo.

Northern Pacific.—Foley Bros., of St. Paul, Minn., have begun work on the extension from Milnor, N. D., west 32 miles to Oaks. (May 25, p. 348.)

Oregon Railroad & Navigation.—The Idaho Extensions R. R. Co. has been organized at Boise, Id., in the interest of the O. R. & N., to build a spur from Wardner to Deadwood Gulch, five miles. Joseph Perrault is President. W. H. Kennedy, Chief Engineer of the O. R. & N., is Chief Engineer.

The company is preparing to build a spur up Government Gulch, Id., to reach the Silver King and other mines.

Paragon.—This company has been incorporated in South Carolina, with a capital stock of $10,000, to build a railroad three miles long from the Paragon kaolin mines to a point between Langley and Bath on the Southern.

Pascagoula & Northern.—Surveys are reported completed for this line from Pascagoula, Miss., to New Albany, 210 miles. It is stated that building is to be begun soon on the section from Pascagoula to Ellisville, 90 miles. J. W. Stewart, of Pascagoula, Miss., is President. (May 11, p. 312.)

Pennsylvania.—H. S. Kerbaugh, of Philadelphia, has the contract for the extension building from Crabtree, Pa., north about four miles to New Alexandria. (May 18, p. 330.)

Philadelphia & Reading.—Kearns & Eagan, of Philadelphia, and Joseph Ryan, of Woodbury, N. J., are reported to have the contract for a spur from the Port Reading Branch, a short distance west of the Port Reading crossing, to tap clap pits at Woodbridge, N. J.

Prince Edward Island.—J. W. McManus, of Memramcook, P. E. I., has been awarded a contract for building an extension from Southport to Village Green, 12½ miles. His son, Reid McManus, will be engineer in charge.

Sioux Falls & Northwestern.—This company was incorporated in South Dakota, June 4, with a capital stock of $1,000,000, to build a railroad from Sioux Falls southwest about 175 miles via Madison and Brookings to Aberdeen. The incorporators are: H. H. Keith, P. F. Sherman, Porter P. Peck, John W. Tuthill, George Schlosser, Melvin Grigsby and D. L. McKinney.

Southern.—McArthur Bros., of Chicago, are reported to have the contract for reducing grades and changing the track on the Knoxville and Ashville Divisions in North Carolina and Tennessee. (March 23, p. 194.)

Southern Pacific.—An officer writes that the company is considering a cut-off between Chatsworth Park, Cal., terminus of a small branch line out from Burbank, and Moore Park, terminus of a branch leaving the Santa Barbara line at Montalvo. When completed, this would form the last link of low-grade line between San Francisco and Los Angeles, avoiding the heavy grades over the San Fernando Mts. between Burbank and Saugus. (May 25, p. 348.)

Preparations are reported being made for building a spur at Madera, Cal., to the site of the box factory of the Sugar Pine Co., about one-half mile.

St. Louis & San Francisco.—An officer confirms the statement that extensive improvements are to be made on the Kansas City, Osceola & Southern. It is to be entirely rebuilt in accordance with the standards of the company, including the relaying with heavier steel, entire reballasting, the replacing of structures with steel bridges, etc. (June 1, p. 364.)

Stockton & Tuolumne.—The rails for this proposed line are being sent back to San Francisco, and it is probable that the project is dead. The road was graded about two years ago for 17 miles out from Stockton, Cal. It is projected to run east about 35 miles to Summersville. Mrs. Annie Kline Rikert, Grand Hotel, San Francisco, is President. (Oct. 7, 1898, p. 732.)

Trenton, Lawrenceville & Princeton.—Locating surveys are being made for completing the line from Stony Brook, N. J., into Princeton, about 2½ miles. The roadbed between Lawrenceville and Stony Brook is in excellent condition, and the section between Trenton and Lawrenceville is to be ballasted. (May 25, p. 348.)

Union Pacific.—Kilpatrick Bros. & Collins have been awarded the contract for building a cut-off between Evanston, Wyo., and Ogden, Utah, beginning at a point near Almy, Wyo., and running west through Emigrant Canyon. The towns of Echo City, Morgan and one or two other stations will be cut off the line. It is stated that some 42 miles will be saved.

Wabash.—Right of way is reported being secured for the extension from Toledo, O., west about 50 miles to Montpelier. Bids were opened June 5. (April 13, p. 246.)

Waycross Air Line.—A number of new men have become interested in this road and an agreement has been made whereby the line is to be extended at once from Douglas, Ga., northwest about 23 miles to Fitzgerald. (March 2, p. 146.)

Wheeling Terminal.—This company was incorporated in West Virginia, June 7, with a capital stock of $2,000,000, with principal offices at Wheeling, W. Va., and Martins Ferry, O. The incorporators are: James McCrea and Joseph Wood, Pittsburgh, Pa.; J. T. Brooks, L. L. Gilbert and F. J. Mullins, Salem, O. This company is probably successor to the Wheeling Bridge & Terminal, whose property was recently sold at public auction.

Westerly & Jewett City.—The Rhode Island Legislature, on May 31, authorized this company to borrow money for building its proposed line. The time limit for completing the road has been extended to Oct. 1, 1901. J. A. Young, of Griswold, Conn., was an original incorporator in May, 1899. The road is projected from Westerly, R. I., northwest about 20 miles via Voluntown, Conn., to Jewett City. (May 11, p. 312.)

GENERAL RAILROAD NEWS.

Atchison, Topeka & Santa Fe.—Chairman Aldace F. Walker has stated that somewhat less than $4,000,000 in bonds will be issued during the current fiscal year to cover improvements recently completed. (Jan. 12, p. 30.)

Atlantic & Danville.—This company, whose property is leased to the Southern, has made a first mortgage, limited to $4,425,000, to the Mercantile Trust Co., of New York, as trustee, to secure an issue of 50-year 4 per cent. gold bonds. Of this amount $500,000 can be issued only for improvements and the rest will be issued to retire the $1,238,000 5 per cent. bonds, called for payment June 29, and for the partial retirement of preferred stock. The first issue of bonds will be $3,175,000. (Dec. 22, 1899, p. 888.)

Holders of first mortgage 5 per cent. bonds of 1895, which are called for payment June 29, 1900, are notified that J. F. Lisman & Co., 30 Broad St., New York, will exchange the same for a like amount of first mortgage 4's, due 1948, together with a cash payment to the holder of 10 per cent. Deposits must be made on or before June 22.

Atlantic & Lake Superior.—The sheriff of the county of Bonaventura, Que., gives notice that on July 19 he will sell sections of this road from Hamilton Township to Metapedia, 60 miles, and from Hamilton to New Carlisle, 12 miles, together with stations, rolling stock, etc. (Feb. 3, 1899, p. 95.)

Boston & Albany.—The Massachusetts Senate Committee on Railroads, on June 8, submitted a bill approving the lease of this property to the New York Central & Hudson River. The bill reserves the right to the State to reduce rates and fares and stipulates that no more shall be charged for export freight from any point to Boston than is charged to New York, that the facilities for travel and business over the property shall not be diminished. It requires not less than $250,000 a year, beginning with July 1, 1901, until the full sum of $2,500,000 is expended in improving the East Boston Terminals and double-tracking the Grand Junction Line. The Supreme Judicial Court of Massachusetts is granted full jurisdiction to enforce its decrees against the lessee upon complaint of the Attorney-General. The lease is to run for 99 years, and the act takes effect July 1, 1901. (April 20, p. 264.)

Canadian Pacific.—Land grant 5 per cent. bonds of 1881 to the par value of $249,000 have been drawn for redemption at 110 and interest at the office of the Treasurer of the Company at Montreal, Que., interest to cease July 30. (Oct. 27, 1899, p. 754.)

Central Massachusetts.—Preliminary negotiations are reported under way for the sale of this property to the Boston & Maine. The present lease to that company is unsatisfactory. The reported price for the preferred stock is 65, the price of the common being determined by the Legislature or the courts. (April 14, p. 273.)

Central of New Jersey.—The company is reported to have bought a controlling interest in the Lehigh Coal & Navigation Co. (May 11, p. 312.)

Central Vermont.—Notice is given that application will be made at the present session of the Canadian Parliament for an act to authorize the company to acquire and operate the Montreal & Province Line Ry., the Stanstead, Sheffield & Chambly and the Montreal & Vermont Junction.

Chicago & Northwestern.—At the annual meeting held in Chicago, June 7, the stockholders ratified the action of the directors to ratify the lease of certain subordinate roads, and to buy others, as already noted. (May 4, p. 296.)

Cincinnati Southern.—The trustees representing the city of Cincinnati, which owns this property, have indefinitely postponed the consideration of the renewal of the lease proposed by President Spencer of the Cincinnati, New Orleans & Texas Pacific. (June 1, p. 364.)

Cleveland, Akron & Columbus.—A plan of re-organization has been prepared for this property by the Pennsylvania Co., which controls it, whereby the debt will be brought within the earning power and the road put in condition to move its traffic economically. (May 4, p. 296.)

Cumberland & Ohio.—The sale of the Bloomfield Branch to T. B. Reed, representing the bondholders, made in March, has been confirmed by the Court at Louisville, Ky. (June 8, p. 380.)

Erie.—The first mortgage 7 per cent. bonds of the Suspension Bridge & Erie Junction, maturing July 1, 1900, with interest, will be paid at the Treasurer's office, New York, on and after July 2.

Erie & Central New York.—John R. Bland, trustee under the mortgage of Aug. 1, 1895, assumed control of the property on May 12. There are no changes in the officers.

Fitchburg.—The Railroad Committee of the Massachusetts Legislature, on June 11, voted to report the bill permitting the Boston & Maine to lease this property. (April 13, p. 246.)

Hudson Tunnel.—A committee composed of F. B. Jennings, John Young and Horace E. Golding has submitted a plan of reorganization for this uncompleted tunnel under North River, which provides for the organization of a new company under the laws of New York or New Jersey, to be known as the Hudson Tunnel Railroad Co., with authority to issue $3,500,000 common stock, a like amount of preferred stock and $6,000,000 first mortgage 5 per cent. bonds. Estimates made by Charles M. Jacobs, C. E., and confirmed by the Engineering Contract Co., of New York, show that an expenditure of about $2,303,872 must be incurred before the North River Tunnel can be completed and equipped for the effective transit of passengers. The shaft and tunnel have been pumped clear of water, and the engineer, after a careful inspection, reports the present condition of the works under the river as entirely satisfactory. There are outstanding £300,000 of old bonds, and $425,000 of debentures issued in England. The old bonds are to be exchanged at the rate of $150 common stock and $500 preferred stock for each $1,000, and the old debentures at $100 common and $350 preferred for each $1,000. There are also £250,000 in old mortgage bonds held in America as security for loan, to take up which securities are reserved. Of the new bonds, $2,500,000 is to be issued to complete the tunnel, and $1,000,000 in settlement of claims, etc. The remaining $2,500,000 is to be reserved for building the second tunnel, provided such a tunnel shall be deemed necessary.

Louisville, Evansville & St. Louis.—Judge Baker, at Indianapolis, Ind., in the U. S. Circuit Court, on June 9, issued a decree for the sale of this property at a date not fixed. (June 8, p. 380.)

Minneapolis & St Louis.—The company proposes to substitute in lieu of its second preferred and common stock, new stock to be known as preferred and common. There will be no change in the total amount of capital stock. (May 12, 1899, p. 345.)

Norfolk & Western.—The Mercantile Trust Co., New York, trustee, notifies holders of certain bonds that these will be bought at par at maturity. These bonds are Norfolk & Petersburg second mortgage 5 per cent. bonds, maturing July 1; South Side R. R. Co. consolidated mortgage 4, 4½, 5 and 6 per cent. bonds maturing July 1; Virginia & Tennessee R. R. enlarged mortgage 5 per cent. bond maturing June 30. (March 2, p. 146.)

Omaha & St. Louis.—The committee, of which W. E. Roosevelt is chairman, gives notice that a majority of the holders of first mortgage 4's have assented to the agreement of the committee. Legal proceedings to enforce the bondholders' rights are in progress and the committee urges the immediate deposit of all outstanding bonds with the Union Trust Co., prior to June 15, after which a penalty may be imposed. (May 11, p. 312.)

Philadelphia & Reading.—Holders of 10-year sinking fund bonds are notified that bids will be received until noon June 31, at the office of the trustee, 317 Chestnut St., Philadelphia, for the sale of 36 of these bonds at the lowest rate not to exceed par and accrued interest.

Sioux City & Pacific.—The bill has become a law by Congress creating a commission to settle the indebtedness of this company with the United States. (April 20, p. 264.)

Southern.—Georgia Pacific equipment mortgage bonds of July 17, 1889, to the par value of $50,000, have been drawn for payment Aug. 1, at the Central Trust Co., New York. (March 2, p. 146.)

St. Paul & Duluth.—The Minnesota Railroad Commission announces that it will oppose the sale of this property to the Northern Pacific on the ground that it would be a violation of the State law prohibiting the consolidation of parallel or competing lines. (June 8, p. 380.)

Toledo, St. Louis & Kansas City.—The syndicate formed by Hallgarten & Co. and Vermilye & Co. has announced a reorganization plan which provides for the following new securities: $10,000,000 prior lien 3½ per cent. 25-year gold bonds; $6,500,000 first mortgage 4 per cent. 50-year gold bonds; $10,000,000 non-cumulative 4 per cent. preferred stock and $10,000,000 common stock. The stocks are to be vested in a five-year voting trust composed of Frederick P. Olcott, Thomas H. Hubbard and Wm. A. Read. The old securities are to be exchanged as follows: Present 6 per cent. bonds will receive 100 per cent. in new prior lines; 3½, 62½ per cent. in new first mortgage 4's and 30 per cent. in new preferred. Present preferred stock on payment of $20 per share, will receive 75 per cent. in new preferred, and 20 per cent. in new common. Present common stock on payment of $12 per share will receive 25 per cent. in new preferred, and 75 per cent. in new common. The estimated cash requirements of the reorganization are $14,847,982, of which $12,639,000 are for expenses of the old committee and unsettled claims, and $2,208,982 for improvements to the property and syndicate and other expenses. Of this sum, it is expected that about $2,500,000 will be supplied by the stockholders, and the rest by the syndicate. A syndicate is to buy such bonds and stock of the new company as are not acquired by the holders of securities of the old company upon the same terms as those imposed upon the holders of the old securities, and also to buy $875,000 new 4's, $133,750 new preferred and $401,500 new common stock. Until the reserve bonds are issued, the fixed charges under the reorganization will be $575,000 a year. (June 8, p. 380.)

Western New York & Pennsylvania.—Speyer & Co., New York, announce that they will pay the agreed price for the securities of this company: $9 per share for the stock and $300 per bond for the income bonds. The officers of the Pennsylvania announce that the road is to be operated as a part of the Allegheny Division. (April 27, p. 280.)

West Jersey & Seashore.—Sealed proposals will be received at the company's office, Philadelphia, until noon, July 1, for the sale of $31,000 first consolidated mortgage bonds maturing July 1, 1936, at not exceeding par. (March 10, 1899, p. 182.)